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Methods of Appraising Photographic Systems

Part I—Historical Review

By FRED H. PERRIN

Reasons for the unsuitability of resolving power as a criterion of the performance of an optical or photographic system in general are outlined and the newer concepts of acutance and spread function are introduced. The method of computing the edge trace from the spread function is described. The procedure known as convolution is introduced and exemplified by computing the image of a sinusoidal test object. It is shown that such an image is also sinusoidal and of the same frequency as the object but of different modulation and phase and that the properties of such an image give rise to the concept of sine-wave response.

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PERHAPS it was an ancient Assyrian monarch — or his wise man — who first exclaimed with delight at being able to distinguish with a lens minute objects that he could not distinguish without it; for the archaeologist Layard[1] found in the ruins of Sargon's palace in Nineveh a piece of quartz with rounded surfaces that might have been used as a magnifying glass. At any rate, the ability to make fine details individually visible has been taken as a criterion of the quality of optical systems from the earliest times, and this criterion was applied to the photographic plate when the plate was combined with the lens to form the camera. Only very recently have more sophisticated methods come into use, and it is the purpose of this paper to show why these methods are necessary and to explain in an elementary way the concepts on which they are based. Since most photographic systems consist of a photosensitive receiving surface incorporated into an optical system, the concepts of optics have been carried over into photographic technology, and this paper therefore involves a rather extensive discussion of purely optical systems. Other techniques that are not touched upon, such as information theory, have been applied fruitfully, but they are less obvious to workers in photography.

Although the history of the various concepts involved is outlined, no extraordinary attempt has been made to assign priority. Moreover, although the bibliography is extensive, especially with respect to the measurement of sine-wave response, many worth-while papers have perforce been omitted. Nevertheless, this bibliography will serve as a key to the literature.

1. The Resolving Power of Optical Systems

The earliest optical instruments were microscopes and telescopes. It is extremely difficult to make really good artificial test objects for microscopy, so the microscopists had to use natural objects that have a periodic structure, like diatoms, for testing their instruments. The astronomers, on the other hand, were chiefly concerned with double stars, and a point source like a star is amenable both to mathematical computation and to artificial imitation. In 1834 Airy[2]* computed the light distribution in the image of a point as formed by an aberrationless ("diffraction-limited") lens and showed that the image consists of a central disk containing 84% of the light surrounded by weak rings of diminishing intensity, as shown in Fig. 1. When two such images approach each other, the dark space between them increasingly fills up with light until eventually the images coalesce. The size of the central Airy disk is inversely proportional to the size of the camera lens, and hence the images can approach each other closer for a given illuminance drop between them as the lens is increased in size.

The smallest separation of the images at which they can be distinguished individually has always been a matter of disagreement, largely because it depends so greatly on the conditions of observation. The usual criterion is that of

Presented on October 5, 1959, in an abbreviated form, at the Society's Convention in New York, by Fred H. Perrin, Research Laboratories, Eastman Kodak Co., Rochester 4, N. Y.
(This paper was received on October 12, 1959.)

* Sir George Biddell Airy (1801–1892), Astronomer-Royal 1835–1881, investigated image formation by telescopes incidentally to a study of the precision of astronomical observations. A complete bibliography of his 518 papers is in his autobiography, edited in 1896 by his son.

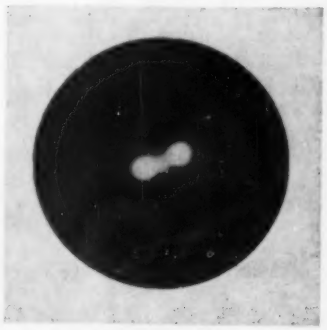

Fig. 1. Photomicrograph of images of two point objects separated by about twice the resolving-power limit of the imaging lens. (Loveland.)

Rayleigh,[3]† who seems to have been the first to use the term *resolving power*. He took as the criterion that the center of one pattern should lie on the first dark ring of the other. This criterion is greatly misunderstood. It is objected to by some workers as being overgenerous but revered by others as if written in tablets of gold by the angels. Rayleigh seems to have selected it purely for its mathematical convenience on the basis that "we may consider this to be about the limit of closeness at which there could be any decided appearance of resolution." For a wavelength of 550 mμ and an aperture of $f/4$, this corresponds to a separation at the film of 1.3 μ if the lens is aberrationless.

Many observations and some theoretical studies have shown that this criterion is indeed overgenerous[4–6] and that the minimum separation that is detectable by the eye under adequate magnification is approximately 1.2 μ under the same conditions. Rayleigh's criterion leads to the formula

$$\Delta = \frac{0.61\ \lambda f}{D} \qquad (1)$$

for the minimum resolvable separation, where λ is the wavelength of the light, f the focal length of the lens, and D its diameter. General experience leads to the same formula but with a coefficient of 0.50 instead of 0.61. This coefficient has been proposed by Conrady[7] for use when evaluating optical instruments as being more realistic than Rayleigh's. On the Rayleigh criterion, the illuminance in the minimum between the images is 26.5% less than at the two maxima; on the Conrady criterion, the illuminance is only about 2.2% less, which is approximately the photometric threshold as found in other connections.

For quantitative studies, line patterns have been found to be better than points. A century ago, Foucault[4] described in a classic paper a test object consisting of a large number of lines and spaces of equal width, and this type is often called by his name. By using a series of patterns of increasing fineness or, in modern terminology, increasing *spatial frequency*, the finest pattern in which the lines can be resolved can be determined. Such patterns are so fine that they must be examined with a microscope.

A somewhat analogous procedure can be followed in a spectroscope by studying pairs of lines of different separation. There is a wide variance between the results of different investigators. Some[8–11] have even detected resolution for separations so small as to result theoretically in a single maximum for the two images on the basis of the analysis used by Airy and by Rayleigh. Such a phenomenon may not be imaginary, however. The Airy-Rayleigh procedure is based on the premise that the two images being resolved are independent with respect to the phase of the emitted light. This is not always strictly true, especially when the illuminating beam does not fill the objective, and then even a single line can look like two or more.[12,13]

2. The Resolving Power and Definition of Photographic Materials

The first study of the resolving power of photographic materials seems to have been made[14] just before the turn of the century. This study was made in connection with astronomical spectroscopy, so it was naturally made in terms of linear patterns. The diffraction treatment used by Airy and Rayleigh was of course not applicable, and the limitation to resolving power was attributed to the granular nature of the emulsion. A decade later photographic scientists everywhere took up the study in earnest, and since then a flood of papers has poured forth discussing the measurement of resolving power and the conditions that affect it.[15]

Resolving power became understandably popular for evaluating the image-forming properties of photographic materials, partly because it seems reasonable that the ability to resolve minute details is an important feature of image quality,[16] partly because the results are expressible in comprehensible terms, and partly because resolving power appears to be an easy quantity to measure (although in reality it requires much skill and painstaking attention to apparently trivial matters of detail). But within recent years it has been increasingly realized that the advantages of resolving power as a criterion of quality are illusory. In the first place, it is not a fundamental property of the photographic material; it depends upon many more factors than the turbidity characteristics of the emulsion. In the second place, the criterion of resolution is uncertain, as was indicated in the preceding section. The value obtained also depends on the type of receiver used for examining the image. The writer has repeatedly noticed that a microdensitometer will make a clear trace of finer lines than can be resolved visually, and that there is no apparent correlation between the two resolution thresholds. Moreover, ordinary negative materials will resolve lines that are about ten times finer than the eye can see in a contact print at the ordinary reading distance; on the other hand, an observer is not interested in the resolution of details that he cannot see, but he wants the large details that he can see to be reproduced with satisfactory clarity. For some camera lenses, the image plane for maximum resolving power does not correspond to the plane for maximum sharpness,[17–19] and a photographer unconsciously focuses on the plane of maximum sharpness.

Conversely, as the writer can testify, very fine resolving-power images can sometimes be distinguished in the microscope although the images do not "look good." The attribute of a photograph that represents the clarity with which details are reproduced may be termed *photographic definition*,[20] and it is probably determined in large measure by the sharpness of the picture.[21] Graininess and the fidelity of tone reproduction also undoubtedly enter into an observer's estimate of definition, but the four attributes — resolving power, sharpness, graininess, and tone reproduction — do not go hand in hand and they vary independently within extremely wide limits.

A well-known phenomenon that sometimes affects definition but has not been mentioned is *halation*, which results from the reflection of light at the back surface of the plate or film base. This can be prevented by such procedures as backing or double-coating, so it will not be considered further. In multilayer coatings, like those of color films, something akin to halation takes place at the individual layers. The grains in a layer diffuse or scatter light in all directions, and some of this light is diffused backwards from the deeper layers to the upper. In a single-layer coating, this diffusion is responsible for the difference between the "incident" exposure and the "effective" exposure; in a multilayer coating, a weakly diffusing layer that itself would produce a sharp image may produce an unsharp image because the next layer below diffuses back into it strongly.

3. Acutance and Sharpness

Except under unusual conditions, as when a special pictorial effect is desired, the photographic definition should be as good as the observer would expect to see in the original scene. If, as seems likely, the most important attribute of definition is sharpness, the criterion of interest must be some property of the microdensitometer trace of the edge of the image — the graph relating the change of density at the edge to the distance across the edge. When the film shown at the top of Fig. 2 is partially covered by a knife-edge and exposed to light, the light in the illuminated region does not stop at the knife-edge but is diffused into the shielded region by reason of reflection, refraction, diffraction, and scattering within the emulsion. This light in the shielded region is gained at the expense of the illuminated region adjacent to the knife-edge, so a microdensitometer trace of the resulting density distribution has somewhat the form shown by curve D in the figure. Some property of this trace must determine

† Rayleigh, 3rd Baron (John William Strutt, 1842–1919), professor at Cambridge and at the Royal Institution, Nobel prize winner 1904, made theoretical and experimental studies in many branches of physics. His papers are collected in six volumes published by Cambridge University, 1899–1920.

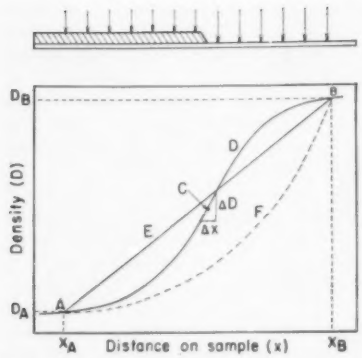

Fig. 2. Distribution of density in image of knife-edge formed as sketched at top. Curve D is typical of the edge trace so formed; E and F are hypothetical curves having the same average gradient between A and B as D has. The gradient at any point, such as C, is $\Delta D/\Delta x$.

how sharp the edge appears to an observer.

One possibility is that the maximum gradient, which is to be found near the center of the curve, is the determining factor. This, however, has been found not to be true,[22] which is not surprising because an edge trace with a sweeping toe and shoulder would probably give rise to a lower sensation of sharpness than would a trace with an abrupt toe and shoulder, even when the maximum gradient of both is the same. Attempts to correlate the average gradient between two points, such as A and B, in the toe and shoulder were equally fruitless, which again is not surprising because curves like E and F, which have the same average gradient between A and B as does curve D, might be expected to give rise to different sensations of sharpness.

A procedure that leads to a quantity which has been found to correlate well with sharpness was outlined some years ago in this *Journal*.[19] The procedure in detail is as follows: In Fig. 3, let the edge trace be divided into sections by partitioning the distance axis into equal increments Δx. The points A and B on the trace that limit the region over which this partition is to be made must be carefully selected. It has been found that these points should represent a gradient of 0.005‡ when the distance is expressed in microns, as is usual in these computations. Starting at A, then, the increment ΔD_1 corresponding to the first section Δx_1 is measured and the quantity $(\Delta D_1/\Delta x_1)$ is computed. This is done for every section of the trace,

‡ This value was found empirically to give the best correlation with enlargements made at a magnification of 4 times and is used for routine evaluations. When the materials under study are to be used for other purposes, a different value for the cutoff slope might be found to be more suitable.

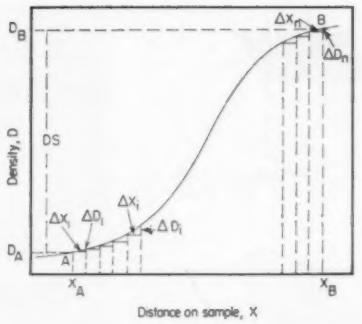

Fig. 3. Edge trace showing partition into n sections of equal length Δx along the x-axis. The limits of summation are A and B, and the density scale $DS = D_B - D_A$.

ending at Δx_n, which is at the upper limit B. The individual quantities so computed are then added together to give $\Sigma(\Delta D_i/\Delta x_i)^2$, where i represents any of the sections 1, 2, 3, ..., n. This sum is then divided by n, the number of sections, to give the mean square of the gradient taken at equal x-increments, which is expressed mathematically as

$$\overline{G_x^2} = \frac{\Sigma(\Delta D_i/\Delta x_i)^2}{n}. \qquad (2)$$

The quantity thus computed is an adequate index of sharpness if the density scale DS, which is defined as the difference between the density D_B at B and the density D_A at A, is the same for all the samples being compared. It is not certain what effect a change in density scale has, but the indications are that sharpness is inversely proportional to the density scale. The objective correlate of sharpness has therefore been defined§ as

$$Acutance = \overline{G_x^2}/DS. \qquad (3)$$

The acutance of a material is commonly measured by making a graded series of exposures under a knife-edge and plotting the results as shown in Fig. 4. The curves in this figure are for a high-contrast motion-picture positive film, a fine-grained landscape film, and a high-speed landscape film.

4. Photographic Definition and Quality

It was pointed out earlier that one's opinion of the "definition" of a photograph depends primarily on the clarity with which details are reproduced. It arises from many factors acting conjointly, but one would expect *a priori* that sharpness and resolving power would be among the most important. An investigation[20] was made in which such factors as the graininess and tone characteristics of a set of photographs

§ When the concept of acutance was first developed,[19] it was tentatively proposed that DS should be introduced as a factor, but experience (and certain theoretical considerations) indicates that it should enter as a divisor.

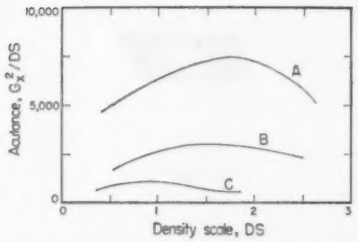

Fig. 4. Acutance curves of three typical materials. A, high-contrast motion-picture positive film; B, fine-grained landscape film; C, high-speed landscape film. Values of x are in microns.

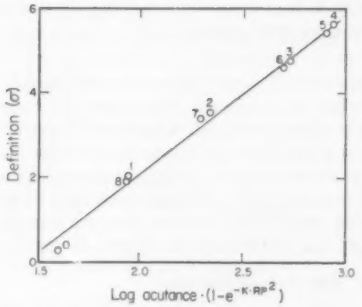

Fig. 5. Definition of a set of photographs in statistical units as determined by a jury of observers plotted against the logarithm of expression (4) suitably averaged over each of the photographs. The straight line was drawn by the method of least squares.

were held constant but the acutance and resolving power were varied. The results are shown by Fig. 5. The linear relation exhibited by this graph shows that a one-to-one correspondence obtained between the definition of the photographs as evaluated by a group of observers and the mathematical quantity,

$$Acutance \cdot (1 - e^{-k \cdot RP^2}), \qquad (4)$$

where RP is resolving power and k is a quantity that probably depends chiefly on the conditions of observation and was found to be equal to 0.007 for the conditions under which the experiment was made. It will be noted from this expression that acutance is the controlling factor as long as the resolving power exceeds about 10–20 lines/mm, which is approximately the limiting resolution of the eye at a reasonable reading distance. As the resolving power diminishes below this value, it becomes an increasingly important factor, indicating that an observer is as dissatisfied when the resolution in the photograph is below what he expects as he is when the sharpness is below what he feels is convincing.

Another experiment may be cited,[21] the variables this time being graininess and sharpness, and in this case the observers attached much more weight to sharpness than to graininess. Interestingly

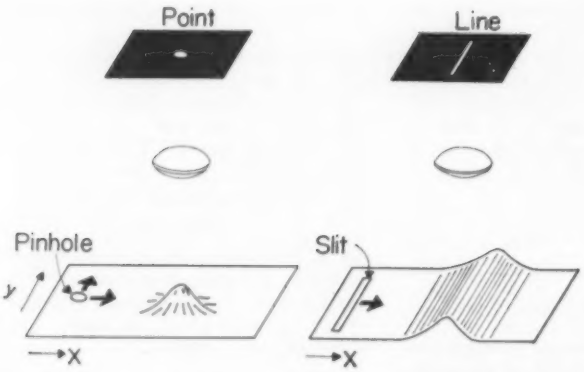

Fig. 6. Formation and scanning of point spread-function (left) and line spread-function (right).

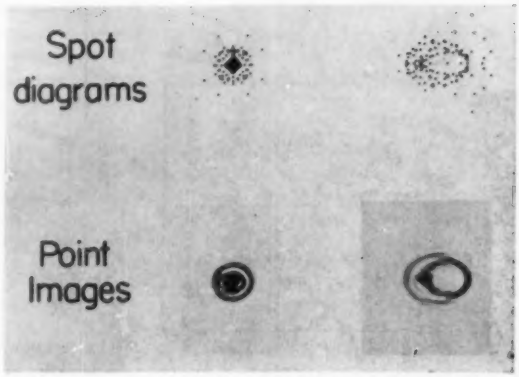

Fig. 7. Photomicrographs of images of a point object formed by a certain lens on the axis (left) and 5° away (right). The spot diagrams, computed from the design data, are plotted above.

enough from a semantic standpoint, when the observers were asked to rank the photographs on a basis of "quality" (a term that was not defined in the instructions), they attached significantly more importance to graininess than they did when asked to rank the pictures on the basis of definition.

5. The Spread Function

Although the concepts discussed hitherto are of value in appraising the characteristics of photographs, they do not furnish a method for analyzing a photographic system. What is needed is a common language for describing the performance of the various elements in the system so that the complete system can be designed or "engineered" from a knowledge of the behavior of its constituent elements.[22]

Such a common language is furnished by the spread function. It was pointed out in Section 1 that, even when the object is a point of infinitesimal size and the lens is perfectly aberrationless, the image consists of a disk of light whose luminance is greatest at the center and which is surrounded by a series of faint rings of decreasing luminance. The mathematical description of such a light distribution is commonly termed a *spread function;* it specifies the illuminance at each point in the pattern, and a plot of it may be considered the profile of a "light mound."

The formation of such a light mound is shown schematically at the left in Fig. 6. If it is scanned with a microdensitometer furnished with a pinhole, its profile or curve representing the spread function is traced by the instrument. The shape of the curve thus formed will, in general, depend upon the direction of scan, but in photographic emulsions the grains are randomly arranged and therefore the spread function is symmetrical. The spread functions of lenses, on the contrary, are rarely symmetrical except on the axis, and it is therefore necessary to scan them in directions that are radial and tangential with respect to a circle whose center is on the axis of the lens. This is shown by the lower pair of images in Fig. 7, which are the images of a point formed by a certain lens on the axis and 5° away. (The upper pair of figures are the corresponding spot diagrams, computed from the design data, to show how accurately the performance of the lens can be predicted.)

Since it is difficult to make a pinhole pass exactly through the center of the light mound, it is customary to make the apertures of microdensitometers in the form of a slit. This results in an integration in the long direction of the slit, and therefore the point source can be replaced by a line source, as shown at the right in Fig. 6, with a great increase in the amount of energy available for measurement. The result is a *line* spread-function, so called in contradistinction to the *point* spread-function that results when the image of a point is scanned with a pinhole. The line spread-function is the integral of the point spread-function in one direction.

Attempts have been made to use this spread function as an index of the quality of the system. One method that was proposed long ago is based on the principle that the center of the Airy disk formed by a perfect lens has the highest illuminance that any system of a given aperture can produce. The ratio of the illuminance in the center of the point spread-function in question to the illuminance in the center of the Airy disk formed by an aberrationless system of the same relative aperture was suggested[24] as a criterion of quality and was called "definition brightness." A somewhat similar criterion has been proposed more recently.[25] This is the diameter of the circle within which a certain fixed proportion — 30%, say — of the light is enclosed. Although such criteria are obviously deficient in the respect that they do not indicate the *shape* of the spread function, simple criteria of this sort must be adopted for incorporation in procedures of automatic lens design in which the criterion is applied by the computing machine. An idea of the shape can be gained by plotting circles within which is 10%, 20%, etc., of the light to make a sort of topographic map of the spread function, and lens designers find such a map useful for visualizing the quality of the image.

6. Convolution

The spread function is the brick, so to speak, out of which the entire optical and photographic image structure is constructed. Since it represents the image of a single point or line, as the case may be, the image of any object whatever can be computed by adding together in a suitable manner the spread functions corresponding to all the points and lines that together make up the object. The simplest example is a uniformly illuminated field bounded by a straight knife-edge, as sketched in Fig. 8. Each luminous linear element, of which four are sketched in the figure, forms its own line spread-function and these add together to form the complete image of the knife-edge. The summation is sketched in the figure for the point x_0. A little consideration will show that the sum of the ordinates of the ensemble of elementary spread functions at this point is equal numerically to the sum of all the ordinates of the spread function No. 4 from the extreme lefthand end of x_0. If $A(x)$ is the algebraic expression representing the line spread-function of the lens, the luminance represented by the edge trace at x_0 is

$$I(x) = \int_{-\infty}^{x_0} A(x)\,dx. \qquad (5)$$

The lower limit must be taken formally to be $-\infty$ because the line spread-function trails off indefinitely; in a numerical evaluation, the lower limit would of course be the abscissa for which the ordinate equals the smallest significant figure in the computation.

Given the curve representing the spread function, therefore, the distribution of light at the edge can be computed by partitioning the curve into sections, each having a constant small value of increment Δx along the x-axis, as was done in Fig. 3. The first increment, ΔA_1, along the axis of ordinates, corresponding to the first increment Δx_1 along the axis of abscissas, is measured and plotted against x, then the next increment, ΔA_2, is measured and added to ΔA_1, and the sum is plotted at the point $(\Delta x_1 + \Delta x_2)$ on the x-axis. This procedure is repeated until the entire spread function is covered, and the result should be a curve representing the trace of the image of a knife-edge as determined with a microphotometer. The soundness of this procedure has been shown experimentally elsewhere.[26]

If the edge trace is the integral of the spread function, the spread-function should be the derivative of the edge trace, or

$$A(x) = dI(x)/dx. \qquad (6)$$

But $dI(x)/dx$ is simply the slope of the edge trace at x, which means that, given the edge trace, a plot of its slope against x should be the spread function. The soundness of this conclusion has also been proved experimentally.[26]

The line spread-function can be used to determine the light distribution in the image of any one-dimensional object, by which is meant an object in which the luminance is constant in one direction, like a Foucault resolving-power test object. Let $G(x)$ be the distribution of luminance as a function of the distance x in such an object. To take a simple example, the distribution might be sinusoidal so that the luminance would vary as the sine (or, more conveniently, as the cosine) of the distance x multiplied by a constant. In mathematical terms, this would be

$$G(x) = b_0 + b_1 \cos 2\pi\nu x, \qquad (7)$$

where b_0 is the mean luminance, b_1 the amplitude, and ν the spatial frequency in lines per unit distance. Usually the ratio of the amplitude b_1 to the mean value b_0 is of more interest than the value of the amplitude itself, and this ratio, called *modulation*, is defined as

$$M = b_1/b_0. \qquad (8)$$

The cosine function is given merely as an example, however, and the procedure described here can be followed whatever the form of $G(x)$.

Referring to Fig. 9, every line element of the object, such as P, Q and R, forms a line spread-function as shown. Call this line spread-function $A(\xi)$, where ξ is measured from the point in the test-object image at which the illuminance is to be determined. Since $G(x)$ is in the object space and $A(\xi)$ is in the image space, the quantity x must be multiplied by the lateral magnification m produced by the lens wherever it appears in $G(x)$, but to avoid complications, the factor m will be disregarded in this treatment. In any numerical evaluation, it must be considered.

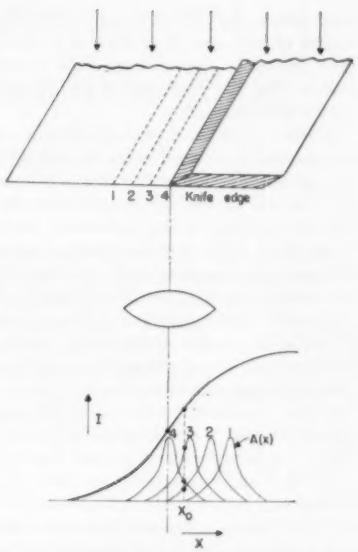

Fig. 8. Formation of edge trace $I(x)$ as summation of elementary line spread-functions $A(x)$. The summation of four elements is indicated for the position x_0.

To get the illuminance in the image at x, the elementary spread functions have to be added up exactly as was done for the knife-edge. A significant difference, however, is that now the various spread functions do not have the same height, so each spread function must be multiplied by the height of the object function corresponding to it, which is $G(x - \xi)$. The illuminance of the image at point x is therefore

$$F(x) = \int_{-\infty}^{\infty} A(\xi)G(x - \xi)\, d\xi. \qquad (9)$$

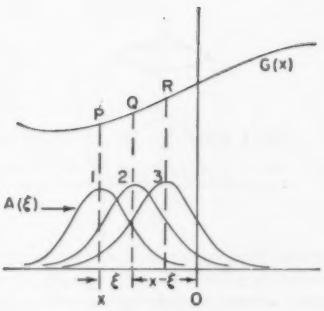

Fig. 9. Sketch illustrating the convolution of an object function $G(x)$ with a spread function $A(\xi)$.

The operation indicated by this integral is known mathematically as the *convolution* of the object function $G(x)$ with the spread function $A(\xi)$.

Any one-dimensional object function $G(x)$ can of course be convoluted with any one-dimensional spread function $A(\xi)$, but a particularly important and simple type of object function is the sinusoidal function represented by Eq. (7). Equation (9) then becomes[27]

$$F(x) = b_0 \int_{-\infty}^{\infty} A(\xi)d\xi + b_1 \int_{-\infty}^{\infty} A(\xi) \cos 2\pi\nu(x - \xi)\, d\xi. \qquad (10)$$

The significance of this equation can be understood from Fig. 10. At A is shown a spread function $A(\xi)$ and at B is shown as the solid curve an object function $G(x)$. The spread function that was selected for illustration happens to have the form

$$A(\xi) = 0.5 + 0.5 \cos 2\pi\xi/d, \quad (-d/2 < \xi < d/2) \qquad (11)$$

but any one of many functions might have been selected. The critical feature is that the object function $G(x)$ represents a sinusoidal test object.

The operation represented by Eq. (10) was carried out numerically. Since the first integral in Eq. (10) is the area under the spread function, the equation

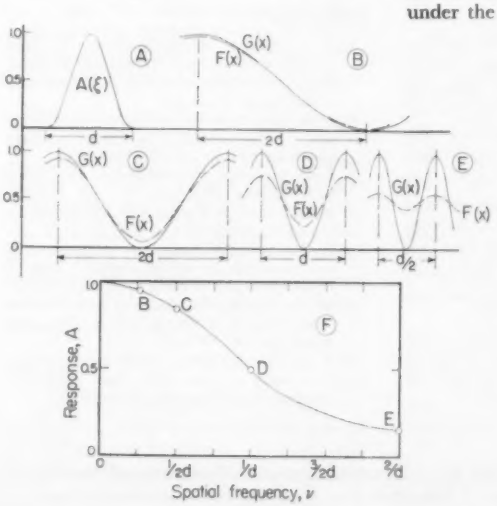

Fig. 10. Diagrams illustrating convolution and sine-wave response. *A*, hypothetical spread function $A(\xi)$ of width d; *B*, sinusoidal object function $G(x)$ and image function $F(x)$ for line spacing $4d$; *C*, same, spacing $2d$; *D*, same, spacing d; *E*, same, spacing $d/2$; *F*, ratio of modulation of $F(x)$ to that of $G(x)$ vs. reciprocal line spacing or spatial frequency.

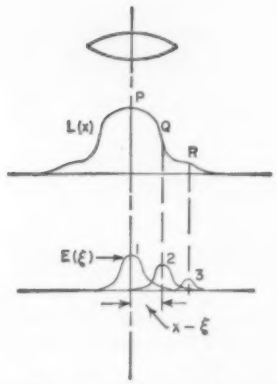

Fig. 11. Sketch illustrating the convolution of a lens spread-function $L(x)$ with an emulsion spread-function $E(\xi)$.

can be normalized by division by this quantity, and the result is then the broken curve $F(x)$ as shown at B in Fig. 10. This is, of course, a cosine curve like the object curve $G(x)$, and the comparison of the curves is facilitated by transforming Eq. (10) into the equivalent equation

$$F(x) = b_0 + b_1 |A^\sharp(\nu)| \cos(2\pi\nu x - \phi). \quad (12)$$

The quantity ξ seems to have disappeared but it is actually included in the factor[‖] $|A^\sharp(\nu)|$. A comparison of this equation with Eq. (7) shows that it is sinusoidal like the object function $G(x)$, which means that the light distribution in the image is exactly similar in *form* to the distribution in the object. This property of the sinusoidal pattern was shown from a different approach many years ago.[20] In detail, however, there are two differences. The first is what may be called a phase angle ϕ, but this will be disregarded for the moment because it vanishes as long as the spread function is symmetrical. The second difference is that the modulation in the image is

$$M' = b_1 |A^\sharp(\nu)| / b_0, \quad (13)$$

which is $|A^\sharp(\nu)|$ times as great as the modulation in the object. This factor is in a sense the response of the imaging system.

The separation of the lines or the "wavelength" in this test object was assumed to be $4d$, where d is the width of the spread function, whence the frequency $\nu = 1/4d$. The corresponding graphs for frequencies of $1/2d$, $1/d$ and $2/d$, respectively, are shown by curves *C-E*. The modulation was measured for each graph and the four corresponding values of response were plotted at F to give the curve shown there. This curve shows how the response of the system varies with frequency.

When an optical or photographic process consists of several steps in cascade, the spread function of the entire process can be computed by convoluting the spread functions of the individual steps. A simple example is the ordinary camera, where a lens forms an optical image on the emulsion, the emulsion forms an "effective" image within itself by reason of diffusion at the silver halide grains, and the darkroom processes form a photographic image consisting of silver grains. We are concerned with only the first two steps, which are sketched in Fig. 11. Here the lens forms a spread function $L(x)$ of a luminous point or line (not shown) on the emulsion. This emulsion in turn forms a spread function $E(\xi)$ of each element, such as P, Q, and R, of the lens spread-function. The analogy between this figure and Fig. 9 is evident, with $E(\xi)$ taking the place of $A(\xi)$ and $L(x)$ taking the place of $G(x)$. The distribution of the effective light within the emulsion is therefore

$$I(x) = \int_{-\infty}^{\infty} E(\xi) L(x - \xi)\, d\xi, \quad (14)$$

which is exactly analogous to Eq. (9). The light distribution given by this equation is obviously the spread function of the entire photographic system, so it can be combined in turn with the object function, as outlined previously. This method of computing the behavior of a system can be applied to any number of steps. Nevertheless, the mathematical computations are prolonged and tedious, and a derived function that is often quite adequate is more likely to be used when possible. This function — which is the $|A^\sharp(\xi)|$ discussed above — is known as *sine-wave response* and is important enough to deserve a treatment by itself.

[‖] The symbol used for this quantity is unnecessarily complicated in the present connotation, but it was adopted to facilitate following the more detailed treatment in reference 27.

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NOTE: *Part II — Manipulation and Significance of the Sine-Wave Response Function* will appear in the April issue of the *Journal*.

Interpretation of Dimensional Changes in Cellulose Ester Base Motion-Picture Films

By PETER Z. ADELSTEIN and JOHN M. CALHOUN

The factors which affect the dimensions of solvent-cast, cellulose ester base motion-picture film are discussed in order to correct some of the misinterpretations that are sometimes made. The distinction between standard film dimensions at the time of manufacture and actual film dimensions at the time of use is clarified. The stacking or cancellation of dimensional errors caused by variations in cutting or perforating, relative humidity, temperature, processing and aging is explained. The application of the principles discussed to practical problems in the motion-picture and in the instrument and data-recording fields is illustrated.

A more apt title for this paper would be "Misinterpretation of Dimensional Changes in Film." In spite of the fact that a considerable amount of data on the dimensional characteristics of film and many explanations of shrinkage phenomena have been published in past years, there is still a great deal of misunderstanding on this subject. Permanent shrinkage caused by solvent loss is often confused with humidity and thermal changes, although the latter are temporary and reversible. In addition, the term "shrinkage" is often confused with "deviation from standard pitch." Accelerated tests are sometimes used incorrectly in attempting to predict normal aging shrinkage. It is the purpose of the present paper to attempt to clarify some of these misunderstandings, as they pertain to motion-picture and photographic recording applications and film dimension standards.

The exact dimensions of motion-picture film are important in the proper operation of all types of equipment — cameras, processing machines, printers and projectors. This means that film dimensions need to be controlled as accurately as possible *at the time of use*, which may cover a period of many years. The dimensions of motion-picture film at the time of cutting and perforating have been carefully standardized, largely by the work of the SMPTE in the development of American Standards. However, control of dimensions at the time of use is more difficult. It depends largely on the inherent dimensional stability of the film achieved by the manufacturer and the control over temperature and relative humidity exercised by the user, both of which have improved over the years.

Presented on October 5, 1959, at the Society's Convention in New York by Peter Z. Adelstein (who read the paper) and John M. Calhoun, Eastman Kodak Co., Manufacturing Experiments Div., Kodak Park Works, Rochester 4, N.Y.
(This paper was received on November 13, 1959.)

Unavoidable dimensional changes in film must be allowed for in the design of film handling equipment. All too often, equipment designers either ignore possible dimensional changes in film, or interpret published coefficients incorrectly. It is also sometimes assumed erroneously that standards for the dimensions of motion-picture film provide accurate dimensions at the time of use. These difficulties have been aggravated in recent years because of the many new engineering concerns active in motion-picture and instrument and data-recording fields, whose background is in electronics rather than in photography.

Only a brief literature review will be given. Some shrinkage data for early acetate motion-picture films were provided by Maurer and Bach in 1938.[1] The mechanism of film dimensional change was explained by Calhoun in 1944[2] according to the following classification:

1. Temporary or reversible —
   (a) humidity expansion or contraction due to a change in the equilibrium relative humidity, and
   (b) thermal expansion or contraction due to a change in temperature;
2. Permanent shrinkage due to loss of residual solvent, plastic flow of the base or release of mechanical strain.

The shrinkage characteristics of triacetate (high acetyl acetate) film were described by Fordyce in 1948[3] and extended in 1955.[4] The concept of frequency distribution of film dimensions was introduced by Robertson in 1948[5] and again in 1951.[6] Accurate methods of measuring the dimensional change characteristics of film are specified in a recent American Standard.[7]

Definitions

Some of the misunderstanding concerning film shrinkage is undoubtedly due to confusion in terminology. In fact, the term "shrinkage" should be reserved for permanent shrinkage and not used as a general term synonymous with "dimensional change." The following definitions taken from an American Standard[7] should prove helpful.

"*Humidity Expansion (or Contraction).* The dimensional change caused by the gain (or loss) of moisture following changes in the relative humidity of the ambient air at constant temperature."

"*Thermal Expansion (or Contraction).* The dimensional change caused by a rise (or fall) of temperature at constant relative humidity. (This is, more correctly, an apparent thermal expansion, since the moisture content of film and paper varies slightly with temperature at constant relative humidity.)"

"*Dimensional Change Due to Processing.* The permanent dimensional change which is caused by the wetting and drying of the sensitized material during photographic processing. It is measured after equilibration at the same relative humidity and temperature as used for the original measurement and is expressed as a percentage."

The following additional definitions are offered.

Pitch. The distance between similar edges of two successive perforations. This is dimension *B* in American Standards for the dimensions of motion-picture film. (Longitudinal pitch is assumed unless transverse pitch is specified.)

Average Pitch. The distance between similar edges of two perforations at least 8 in. apart divided by the number of perforations in between the selected edges.

Dimension L. The length of 100 consecutive perforation intervals as defined in American Standards for motion-picture film dimensions.*

Deviation From Standard Pitch. The difference between average pitch and a specified "standard pitch," usually expressed as a percentage, either positive or negative. (It is necessary to specify 0.1866- or 0.1870-in. standard 35mm film pitch, and 0.2994- or 0.3000-in. standard 16mm film pitch.)

Shrinkage. A negative change in dimension between two measurements made at different times but under the same

* In the present paper, dimension *L* is calculated from measurements of average pitch made using a 10-in. gauge (54 perforations on 35mm film). For all practical purposes this is equivalent to measurements made over 100 perforation intervals.

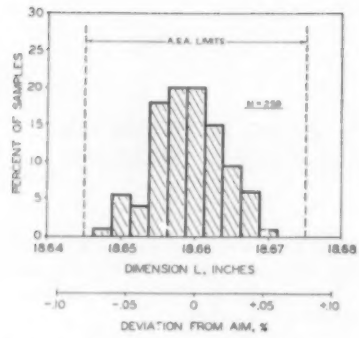

Fig. 1. An example of variation in dimension L of triacetate 35mm negative motion-picture film at time of perforating. Dimension L is length of 100 consecutive perforation intervals. ASA limits are shown for PH22.93-1953.

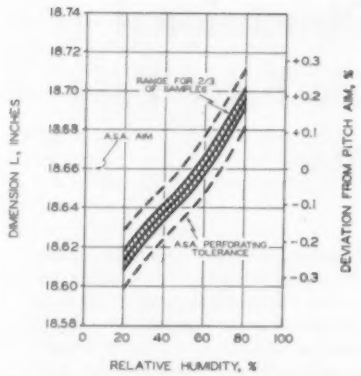

Fig. 2. Change of dimension L with relative humidity at 70 F for black-and-white 35mm motion-picture negative film at nominal ASA (PH22.93-1953) dimension in equilibrium with air at 60% RH at time of perforating. Dimension L is the length of 100 consecutive perforation intervals.

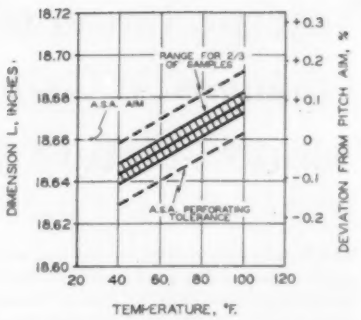

Fig. 3. Change of dimension L with temperature for black-and-white 35mm motion-picture negative film at nominal ASA (PH22.93-1953) dimension in equilibrium with air at 70 F at time of perforating. Relative humidity is constant at 60% RH. Dimension L is the length of 100 consecutive perforation intervals.

equilibrium conditions of temperature and humidity.

There is frequent confusion between the last two terms. It has been common to speak of the measured average pitch difference of a 35mm film sample, for example, as "per cent shrinkage," meaning that the pitch differs from 0.1870 in. by a certain percentage. However, the film may not have been perforated 0.1870 in. pitch, in which case it is incorrect to speak of the difference as "shrinkage." Instead, it should be called "deviation from standard (0.1870-in.) pitch." Actual shrinkage can be determined only if both original and final measurements have been made.

PART I. FACTORS AFFECTING FILM DIMENSIONS

Having discussed the importance of film dimensions and the different terms used in this field, it is worth while considering the different factors which influence film dimensions. These are the effects of cutting or perforating, humidity, temperature, processing and age. As was pointed out, only the last two of these can correctly be called "shrinkage."

In the following review of these factors, discussion is limited to their effects upon the longitudinal pitch of 35mm motion-picture negative film. This particular dimension and this type of film are chosen as an example only. It should be realized that the same behavior pattern exists with all other film dimensions. Furthermore, dimensional changes are generally 20–40% greater in the width direction of the film than in the length direction.

Cutting and Perforating Variations

In the manufacture of motion-picture film, the cutting and perforating operations are carried out under very tight tolerances. Nevertheless, it is realized that some variation in the dimensions of the film is unavoidable owing to very small variations in slitter knife settings, punches, pilots and dies. Variations in the moisture content of the film at the time of slitting or perforating will also cause deviations from the standard dimensions. For these reasons, all American Standards on dimensions for motion-picture films are written with tolerances clearly indicated. For example, the tolerance for the length of 100 consecutive perforations (dimension L) in American Standard Dimensions for 35mm Motion-Picture Short Pitch Negative Film (PH22.93-1953) is 18.66 ± 0.015 in. This amounts to an allowable deviation about the aim of ±0.08%. *All such tolerances apply immediately after cutting or perforating.*

To illustrate the variation in film dimensions that can occur within ASA tolerances immediately after perforating, a random group of 259 samples of 35mm motion-picture negative film from different perforators was recently measured for average longitudinal pitch. Dimension L was calculated from the average pitch measured with a 10-in. shrinkage pin gauge[7] and the data are plotted as a frequency distribution in Fig. 1.

A frequency distribution is simply a convenient means of showing how many samples in the group measured a given dimension. It may be seen that the distribution is "normal," that is, the largest number of samples have a measurement corresponding to the mean and an approximately equal number have higher and lower values, tapering off to a "tail" at each end of the distribution. It is important to note that a small number of samples have measured values farthest from the mean, as in any normal distribution, even though they are still within ASA tolerances. The significance of this frequency distribution of film measurements will be enlarged upon in a later section.

Relative Humidity

It has been repeatedly pointed out and is very well recognized that all photographic films will change size with change in the relative humidity of the surrounding air. This is a reversible and temporary dimensional change. When the relative humidity increases, the film dimensions will increase, and when the relative humidity decreases, the dimensions become less. Incidentally, it is worth while noting that when a film expands, the perforation hole size becomes larger, and when a film contracts, the hole size becomes smaller.

The humidity coefficients of expansion, expressed as a percentage, for Eastman black-and-white motion-picture negative films on cellulose triacetate support are as follows:

Length direction:
0.007% dimension change/1% RH

Width direction:
0.008% dimension change/1% RH

The slightly higher value in the widthwise direction is an inherent property of the cellulose triacetate film support and is due to its method of manufacture. It should also be recognized that these humidity coefficients are average values determined over the relative humidity range of 20–70%RH.

The change of film dimension is not quite a linear function of relative humidity, as is illustrated in Fig. 2. This shows the effect of relative humidity on dimension L for Eastman 35mm black-and-white motion-picture negative film. Here it is assumed that the ASA aim of 18.66 in. for dimension L coincides with equilibrium at 60% RH. Two envelopes are shown about this curve, the larger one corresponding to the ASA perforating tolerances and the smaller one corresponding to the range for two-thirds of the samples perforated in the group illustrated in Fig. 1. It is quite apparent

from Fig. 2 that a substantial change from the 60% RH condition can cause differences in dimension L which are much greater than those caused by normal variations in perforating. Moreover, it should be realized that any dimensional changes caused by humidity are over and above those due to other causes, such as perforating.

Temperature

As film changes size with relative humidity, so does it change size with temperature. This also is a reversible or temporary change. The thermal coefficients of expansion, expressed as a percentage, for Eastman motion-picture negative films on cellulose triacetate support are:

Length direction:
0.0030% dimension change/1 F

Width direction:
0.0035% dimension change/1 F

Here again the widthwise coefficient is slightly higher than that in the length direction. It is evident that a 1% change in relative humidity causes over twice as large a dimensional change as a 1-deg Fahrenheit change in temperature. The effect of temperature at constant relative humidity on dimension L for Eastman 35mm motion-picture negative film is shown in Fig. 3. It is assumed that the ASA aim of 18.66 for dimension L coincides with a temperature of 70 F, and envelopes are shown about the curve similar to those in Fig. 2.

In practice, there is frequently a partial cancellation of the dimensional changes caused by temperature and by relative humidity. For example, as the temperature increases, the relative humidity often drops and the net dimensional change in this case may well be a decrease in size due to the predominating effect of the decreased humidity.

Processing and Aging

The effects of processing and of aging on the dimensions of photographic film are combined for the purpose of this discussion. Aging shrinkage was discussed in some detail by Fordyce, Calhoun and Moyer.[4]

The magnitude of the film dimensional change due to photographic processing is dependent on the residual solvent content of the film, the processing and subsequent drying conditions, and to some extent on the previous moisture history of the material. In some cases a slight increase in film dimensions may actually result if the film is stretched a small amount in the processing machine. For Eastman motion-picture negative film on cellulose triacetate support, Fordyce et al.[4] reported a lengthwise processing shrinkage of 0.06% and a widthwise shrinkage of 0.07%. As was pointed out, these values were observed after strips of the film were tray processed.

To obtain a measure of the processing dimensional change under trade conditions, 22 pre-exposed rolls of Eastman Tri-X Panchromatic Negative Film, Type 5233 (35mm), from the same emulsion number, perforated on the same perforator, were developed in 22 different commercial processing machines in New York, Rochester and Hollywood. The deviation in average film pitch (after conditioning to standard temperature and humidity) was measured shortly before and after processing. The resulting change in dimension in the length direction is shown by the frequency distribution curve in Fig. 4. The average processing dimensional change was −0.03%, with values ranging from +0.02 to −0.05%. This range is to be expected in view of the different processing conditions that can be encountered. Agreement with the earlier published

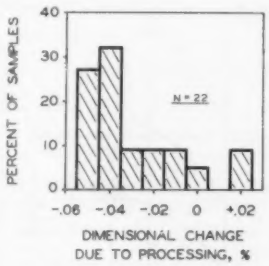

Fig. 4. Change in longitudinal pitch as a result of processing 35mm Eastman Tri-X Panchromatic Negative Film in different commercial laboratories. Film samples were from same emulsion number and perforated on same perforator. Original and final measurements made after conditioning to 70 F and 50% RH.

lengthwise value of −0.06% for tray processing is considered good.

Following processing, film continues to shrink with time. Fordyce, Calhoun and Moyer[4] reported the rate of shrinkage of processed triacetate 35mm motion-picture negative film up to nine months when freely exposed to 78 F and 60% RH circulating air. Keeping tests have since been completed up to six years on these same films, with the results indicated in Fig. 5. After six years, the combined effects of processing and aging shrinkage varied between 0.12 and 0.24%.

Figure 5 indicates the range in film aging shrinkage that has been observed in the laboratory for the majority of films tested. Most of the films will have a shrinkage midway between the extremes shown. This is illustrated in Fig. 6 which shows the combined processing and aging shrinkage of 35mm motion-picture negative film plotted as a frequency distribution after both one and six months at 78 F and 60% RH.

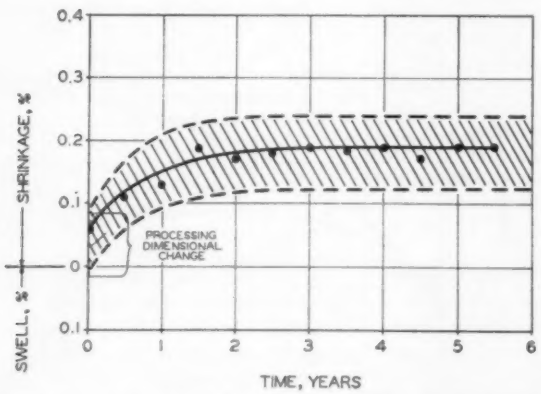

Fig. 5. Processing plus aging shrinkage (lengthwise) of processed triacetate negative motion-picture film after keeping at 78 F and 60% RH. Controlled tests on strips freely exposed to circulating air. Original and final measurements made after conditioning to 70 F and 50% RH.

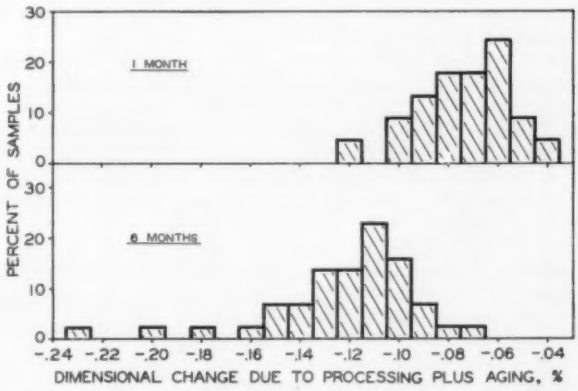

Fig. 6. Processing plus aging shrinkage of triacetate negative motion-picture film after keeping at 78 F and 60% RH. Controlled tests on strips freely exposed to circulating air. Measurements in length direction for 45 emulsion numbers tested at different times. Original and final measurements made after conditioning to 70 F and 50% RH.

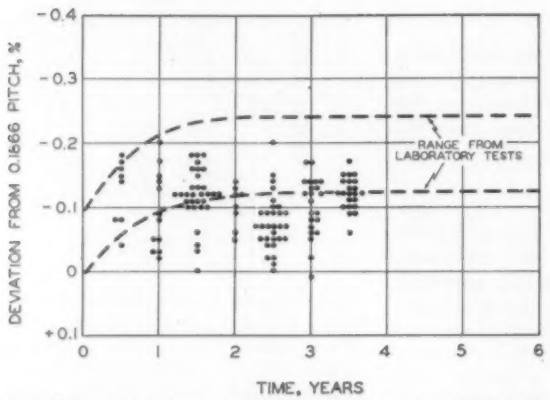

Fig. 7. Deviation from standard pitch of processed triacetate negative motion-picture film as measured in the trade. Data are corrected to the temperature and relative humidity of perforating.

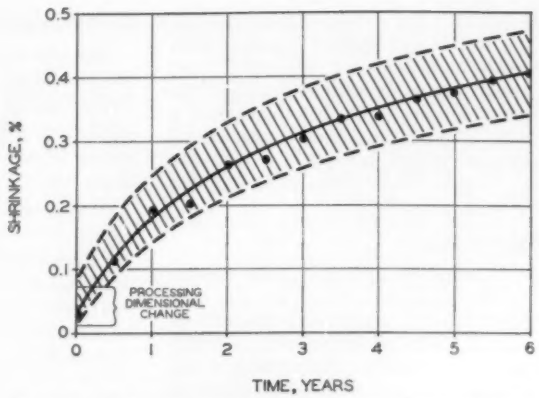

Fig. 8. Processing plus aging shrinkage (lengthwise) of processed triacetate positive motion-picture film after keeping at 78 F and 60% RH. Controlled tests on strips freely exposed to circulating air. Original and final measurements made after conditioning to 70 F and 50% RH.

It should be emphasized that Figs. 5 and 6 were obtained from laboratory tests under carefully controlled conditions and the variations observed are primarily due to the inherent properties of the film. However, the rate of shrinkage is very dependent upon temperature and humidity conditions, the tightness of the film roll, whether the film is in a taped or untaped can or is exposed to the air, and the amount of air circulation if freely exposed to air. Therefore, the variation in aging shrinkage found in the trade is somewhat greater, although the amount of shrinkage tends to be less, than in the laboratory tests. This is best illustrated in Fig. 7 which shows the per cent deviation from standard pitch of processed triacetate motion-picture negative films measured in the trade. The data are corrected to the temperature and relative humidity of perforating. They also include small pitch deviations due to perforating in addition to processing and aging shrinkage.

In addition to tests on negative film, long-time aging shrinkage tests have also been continued on processed triacetate 35mm motion-picture positive film. Three year's keeping was reported by Fordyce et al.[4] and six-year data for the same films are shown in Fig. 8. These results agree with the extrapolations made in the earlier paper. The higher shrinkage of this positive film compared to the negative film is noted.

Figure 9 shows the six-year aging shrinkage values on processed Kodachrome Commercial 16mm Film on acetate propionate support. These results are somewhat lower than those previously extrapolated from the one-year shrinkage measurements.[4] Although Ektachrome Commercial Film, Type 7255 (16mm) has been in production only a relatively short time, the data in Fig. 9 also indicate the aging shrinkage that can be expected for this film.

A comparison of Figs. 5 and 8 will show the different aging characteristics of Eastman motion-picture negative and positive films as indicated by replotting the data as shown in Fig. 10. It is noted that after aging six months at 78 F and 60% RH, both films show approximately the same degree of aging shrinkage. However, it would be very wrong to conclude that the aging properties of these materials are similar. After six years at this keeping condition, the positive-type film has shown a shrinkage of approximately 0.4% compared to 0.18% for the negative.

Stacking or Cancellation of Errors

The different factors which can contribute to the deviation of motion-picture film from standard dimensions have been discussed separately. Film dimensions as observed in practice will be the result of the combined effect of these contributing factors. These may either accumulate by the time of

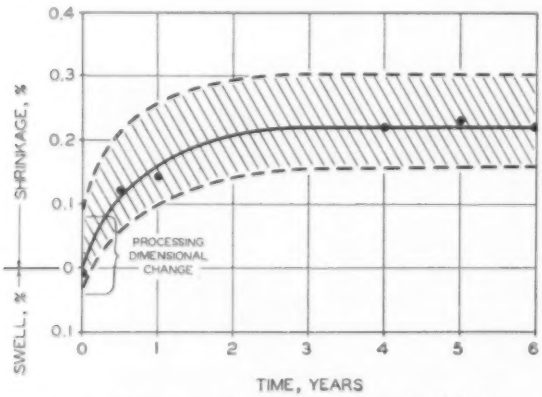

Fig. 9. Processing plus aging shrinkage (lengthwise) of processed 16mm film on acetate propionate support (Kodachrome Commercial and Ektachrome Commercial Films) after keeping at 78 F and 60% RH. Controlled tests on strips freely exposed to circulating air. Original and final measurements made after conditioning to 70 F and 50% RH.

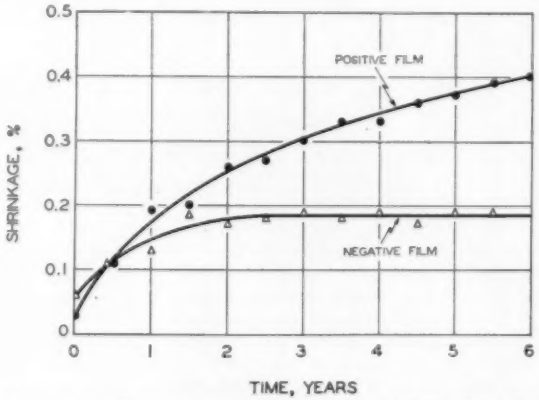

Fig. 10. Typical processing plus aging shrinkage (lengthwise) of processed triacetate motion-picture film after keeping at 78 F and 60% RH. Controlled tests on strips freely exposed to circulating air. Original and final measurements made after conditioning to 70 F and 50% RH.

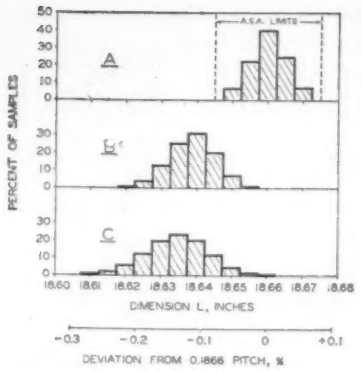

Fig. 11. Examples of the frequency distribution of dimension *L* for 35mm triacetate motion-picture negative film. (A) Observed distribution due to perforating; (B) distribution calculated by combining (A) with variations due to processing and six months aging; and (C) distribution calculated by combining (B) with a relative humidity variation of 45–65%.

use and result in a significant deviation from the cutting standard, or they may cancel so that the film dimension is very close to the standard. This stacking and cancellation is illustrated by the following example. While the data chosen are considered reasonable, they are intended to illustrate a principle and are not to be used as an indication of the exact conditions observed in the trade.

Consider the variation that can occur in the pitch of motion-picture negative film. This is of considerable importance in the printing operation. The case is taken for 35mm triacetate motion-picture negative which is six months old. This is the approximate age of the negative at the time of the first release printing for theater use. Pitch is expressed in terms of dimension *L*, and the calculation of per cent deviation from standard is based on the 18.66-in. value for the raw-stock negative. Table I below indicates the range of dimension *L* that might be expected as a result of perforating, processing and aging shrinkage, and the humidity variation at the time of printing.

The assumption was made that the negative was in equilibrium with 60% RH air at the time of perforating. At the time of printing, it was postulated that the film may be in equilibrium with air varying between 45% and 65% RH.

It can be seen that the possible variation of dimension *L* for six months old negative at the time of printing can vary from +0.02 to −0.32% from 18.66 in. However, it should be emphasized that this is the possible range that may be found. It is important to make the distinction between the *range* of values and the *average* values for film dimensions.

Figure 11 (A) shows the frequency distribution of dimension *L* due to perforating alone (these are the same data as in Fig. 1). Superimposed on this distribution is the effect of six months aging shrinkage which is illustrated in (B). Added to this is the possible relative humidity variation that may be found at the time of printing, as indicated in (C). A frequency distribution of the humidities likely to be encountered in the trade is not available. However, it was assumed that generally the relative humidity would show a normal distribution within a range of 45–65%.

The frequency distribution combining these three variables shows a fairly wide range. However, in the majority of cases the deviation of dimension *L* would be between −0.1 and −0.2% from 18.66 in.

Table I. Variations in Dimension L for 35mm Negative.

	Deviation of dimension *L* from 18.66 in.	
1. Perforating	+0.05 to −0.05%	+0.010 to −0.010 in.
2. Processing and aging for 6 months	−0.07 to −0.18%	−0.013 to −0.033 in.
3. RH variation at time of printing	+0.04 to −0.09%	+0.007 to −0.017 in.
Total:	+0.02 to −0.32%	+0.004 to −0.060 in.

PART II
PRACTICAL SIGNIFICANCE OF DIMENSIONAL CHANGES

The factors contributing to dimensional changes have been pointed out, and it has been demonstrated how the effects of these factors must be combined for any practical considerations. Although all the examples of dimensional change have dealt with dimension *L* and the pitch of motion-picture negative, it is recognized that the same principles apply to other dimensions and to other films.

The practical significance of dimensional changes can be illustrated by many examples in motion-picture work. In this section some problems in the printing of motion-picture film, in film dimension standards and in the photographic recording applications will be given.

The Printing of Short-Pitch Film

It has been established that for optimum quality on continuous printers, the perforation pitch of the negative should be between 0.2 and 0.4% shorter than that of the positive raw stock.[8] To accomplish this, negative films are manufactured with a perforation pitch of 0.1866 in. (PH22.93-1953). This is approximately 0.2% shorter than the 0.1870 pitch used for positive stock (PH22.36-1954). In order that the pitch differential between the negative and the positive will stay within the desired limits, the contribution of all other causes to the pitch difference should be less than 0.2%.

To illustrate the effect of short pitching the negative film, the typical aging shrinkage curves for motion-picture negative and positive film (Fig. 10) have been replotted as per cent deviation from 0.1870-pitch (Fig. 12). This illustrates why negative film with low aging shrinkage may have a greater deviation from 0.1870 pitch than the positive film.

The possible pitch variations of the negative at the time of first printing (six months) have already been discussed. These are replotted in Fig. 13 but in terms of per cent deviation of dimension *L* from 18.70 in. instead of the deviation from 18.66 in., to permit comparison with the raw-stock positive.

It can be seen that the negative can vary from approximately −0.2 to −0.5% from 18.70 in. In addition to this variation of the negative, there are also possible variations in dimension *L* of the positive. These are listed in Table II.

Table II. Variations in Dimension L for 35mm Positive.

	Deviation of dimension *L* from 18.70 in.	
1. Perforating	+0.05 to −0.08%	+0.010 to −0.015 in.
2. Aging of raw stock	0.00 to −0.05%	0.00 to −0.010 in.
3. RH variation at time of printing	+0.03 to −0.03%	+0.005 to −0.005 in.
Total:	+0.08 to −0.16%	+0.015 to −0.030 in.

The assumptions are made that the raw-stock positive is reasonably fresh film taken from a can, and that it has not yet shown any large aging shrinkage. The equilibrium relative humidity of the positive was estimated as being within the range of 55 to 65%. The reasonable assumption was also made that both the negative and the positive are at the same temperature at the time of printing.

The likely variation in dimension *L* of the positive (fresh and unprocessed) is considerably less than that of the negative (processed and aged). However, its variation must be added to the variation calculated for the negative to obtain the differential at the time of printing. The frequency distributions in Fig. 13 show the accumulation of dimension *L* variations for both films as the various factors are taken into consideration. In the majority of cases, the negative-positive difference will most frequently be within the desired 0.2–0.4% limits. However, it is possible for this difference

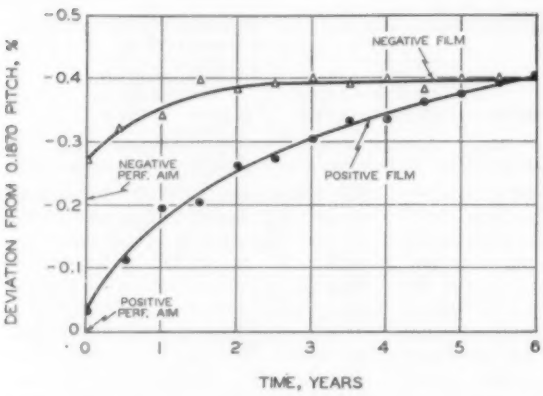

Fig. 12. Typical processing plus aging shrinkage (lengthwise) of processed triacetate motion-picture film after keeping at 78 F and 60% RH, expressed as per cent deviation from 0.1870-in. pitch. Controlled tests on strips freely exposed to circulating air. Original and final measurements made after conditioning to 70 F and 50% RH. (This is a replot of Fig. 10.)

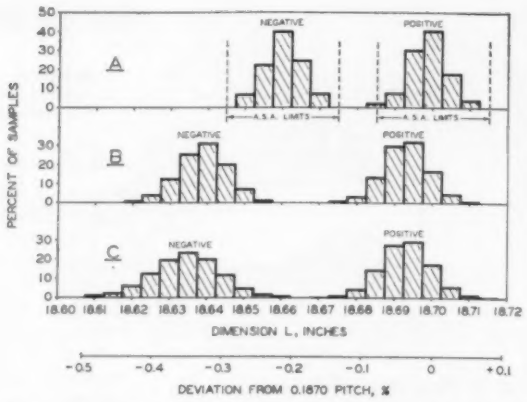

Fig. 13. Examples of the frequency distribution of dimension *L* for 35mm triacetate motion-picture negative and positive films. (A) Observed distributions due to perforating; (B) distributions calculated by combining (A) with variations due to processing and aging at the time of release printing for theater use; and (C) distribution calculated by combining (B) with estimated relative humidity variations at time of printing.

to be as low as 0.05% and as high as 0.60%, depending on the perforating characteristics and aging shrinkage of the films and on the printing relative humidity.

These variations for the different factors were chosen to illustrate conditions that might be encountered in the trade and are not intended to be used as a guide to all conditions that can be found. In fact, the variations are considered to be conservative. The negative-positive pitch differences can be considerably larger if uncontrolled humidity conditions exist.

Film Dimensions Standards

The practical importance of film dimensions in the motion-picture industry has resulted in numerous American Standards on this subject. However, a misunderstanding regarding definitions or specifications for "low-shrink" film which has grown up in regard to a number of these standards needs clarification. One reason this misunderstanding has occurred is that quite arbitrary definitions were employed which were suitable only for the one specific purpose intended and then later were misapplied. Another reason is that the meaning of the term "low-shrink" is indefinite and has changed with the years. Film considered low-shrink some years ago is not considered low-shrink today.

Three groups of standards are involved.

(*1*) *Standards for the dimensions of 16mm film:* These allow a cutting width of 0.628 ± 0.001 in. for "low-shrink" film instead of the usual 0.629 ± 0.001 in.[9] For example, PH22.5-1953 defines low-shrink film as film which does not shrink over 0.2% in up to 30 days at 65–75 F and 50–60% RH after processing.

(*2*) *Standards for the dimensions of short-pitch camera film:* For example, PH22.93-1953 specifies a perforation pitch of 0.1866 in. for 35mm camera film instead of the usual 0.1870 in., and PH22.109-1958 specifies a perforation pitch of 0.2994 in. for 16mm camera film instead of 0.3000 in. For satisfactory printing performance, only "low-shrink" film is intended to be short pitched and it is defined in these standards as film which does not shrink over 0.2% in up to 30 days at 65–75 F and 50–60% RH after processing.

(*3*) *Standards for test films used for various purposes such as sound focusing and flutter tests.* Such films should retain their dimensions as accurately as possible for their useful life, which may be several years. Some test film standards specify a shrinkage limit of 0.2% for up to 30 days at 65–75 F and 50–60% RH after processing (e.g., PH22.98-1955), while others specify a shrinkage limit of 0.5% for 7 days at 120 F and 20% RH after processing (e.g., PH22.43-1953).

These definitions for low-shrink film have been misinterpreted as meaning that such films will never shrink more than the limit indicated. This is quite untrue because the two definitions are based on short-time tests under normal or accelerated conditions and do not correctly predict the long-time shrinkage of different kinds of film, as shown by the data in Table III. This is because different kinds of film may have different characteristic shrinkage curves, as illustrated by the crossover of the two curves in Fig. 10.

Since the existing definitions for "low-shrink film" in American Standards are no longer meaningful, revision is required. This question has been referred to the Film Dimensions Committee of the SMPTE with the suggestion that it recommend improvements in these standards to eliminate possible misunderstanding.

Instrument and Data Recording

In addition to the motion-picture field, dimensional control of film is important in many phases of instrument and data-recording photography. Photorecording has grown tremendously since the end of World War II, in military, commercial and scientific applications. Some of these applications have quite different re-

Table III. Average Lengthwise Shrinkage Characteristics of Current Eastman Motion-Picture Films.

Film	Base	Processing and aging shrinkage, %: 30 Days 78 F, 60% RH*	7 Days 120 F, 20% RH†	6 Years 78 F, 60% RH
Eastman Negative Films..	Triacetate	0.08	0.15	0.18
Eastman Positive Films ..	Triacetate	0.08	0.15	0.40
Kodachrome Commercial and Ektachrome Commercial Film (16mm)..	Acetate-propionate	0.12	0.25	0.22

* Approximate condition used to define low-shrink film in a group of American Standards such as PH22.5-1953.

† Condition used to define low-shrink film in a group of American Standards such as PH22.43-1953.

quirements from those of theatrical or industrial motion-picture photography. Conventional motion-picture negative and reversal films in 16-, 35-, and 70mm, or greater width, are used in some recording applications. For others, special emulsions are coated on motion-picture film support, and in some cases topographic aerial film is used.

Film dimensional changes are important in some recording applications and not in others. In metric (photogrammetric) photography it is desired to measure accurately the distance between certain points on the film. In some cases accurately spaced fiducial marks or reference grids can be exposed on the film,[10] and in missile-tracking photography, stars or accurately positioned ground objects may serve as reference points.[11] Measurements are then made from the reference marks, so that any uniform dimensional change is unimportant. This procedure is highly recommended wherever possible. However, dimensional changes are generally somewhat greater in the width direction than in the length of the film, and this type of linear distortion cannot be readily corrected. Linear distortion can be minimized by preventing large changes in the average dimensions of film where possible (for example, by control of temperature and humidity) or by using topographic aerial film, which is more uniform in length-width properties than motion-picture film.

In some military recording applications, control of ambient temperature and humidity is difficult or impossible. For example, recording cameras on a missile launching site may stand out in the sun for hours. All extremes of climatic and space conditions may exist which will cause greater dimensional changes in the film than normally occur in commercial motion-picture photography. Where measurements on film are necessary, greater and greater accuracy is continually required. These factors lead to increased concern about dimensional changes in the film.

In some types of photographic data processing, electronic devices are controlled by tiny dots (density differences) on the film. If the film is guided from one edge, a dimensional change might shift the dot pattern enough to cause a malfunction of the device. In other applications, actual physical interference may occur if the film is allowed to expand excessively. The importance of temperature and humidity control cannot be overemphasized.

There are so many different types of cameras and applications in recording photography that it is impossible to do more than point out a few general sources of difficulty that may be encountered from film dimensional changes. Each particular application needs to be engineered with its specific requirements in mind.

CONCLUSIONS

Film dimensions are standardized at the time of cutting and perforating and subsequently vary with conditions and age in a fairly well-defined manner. The variations in dimensions of film at the time of use may be additive or may cancel, depending on circumstances. Every kind of film will show some spread in each of its dimensions, which is best understood by means of a frequency distribution curve. It is hoped that the present discussion will clarify some of the questions which arise in equipment design and film use, particularly for engineers who are new to the motion-picture or photorecording fields.

Acknowledgments

Acknowledgments are made to members of the Manufacturing Experiments Division, the Film Testing Division, the Motion Picture and Sheet Film Division, and the Motion Picture Film Department, Eastman Kodak Company, who contributed some of the experimental data.

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Double-System Recording and Editing With Video Tape

By OSCAR F. WICK

It is customary in the motion-picture industry to record and edit sound and picture separately. The procedure affords vastly improved production flexibility over single-system methods. This added flexibility can also be used to considerable advantage with video tape. A system has been designed to provide separate magnetic sound and magnetic picture records.

PRESENT VIDEO-TAPE RECORDERS have their respective recording heads positioned so as to apply sound to the tape approximately 9¼ in. ahead of the associated picture. While this is relatively unimportant when complete programs are recorded and played back, it must be very definitely considered when recorded segments are to be spliced together. At normal running speed, 9¼ in. represents a time interval of slightly more than 0.6 sec. In the editing of recorded material, one must always make certain that a suitable silent interval of this duration exists wherever a splice is to be made. If precautions are not taken, undesirable transition effects, such as an interval of "wrong sound" at the splice, may be encountered.

Despite this problem, it is often possible to perform editing operations that are satisfactory for many purposes, especially if appropriate consideration is given the matter during the original shooting.

Although acceptable in many cases, such single-system editing has certain limitations, recognized throughout the motion-picture industry. The creative freedom resulting from separate handling of sound and picture records is considerable. Not only is the sound-to-picture offset problem avoided, but in addition, either record may be disassembled and reconstructed independently of the other. Music, sound effects, laughter, narration, etc., may readily be added to the original soundtrack through re-recording and dubbing processes. Similar adjustments may readily be made to picture continuity to enhance effectiveness. Also, problems associated with the correction of "fluffs" are usually much easier to solve when sound and picture are separate.

Double-system editing techniques have been available in motion-picture production for many years; and, in replacing the former photographic methods of video recording, tape procedures should, if possible, include the same flexibility.

More than a year ago, with these thoughts in mind, a project was set up at NBC to provide facilities and to devise procedures that would permit a video-tape recording service embodying as many as possible of the desirable features and production conveniences of the photographic process while taking full advantage of all of the resources of the new medium.

While work on this project is continuing, equipment has been installed in the NBC Burbank Studios for the routine performance of double-system recording and editing operations. The arrangement of equipment, and, to some extent, the manner of use is illustrated in Fig. 1.

Sound is recorded on an RCA PM 66 16mm sprocketed magnetic recorder and on the video-tape recorder while the picture is fed to the video-tape recorder and to the kinephoto monitor which, in turn, is photographed by a standard 16mm single-system video recording camera. In addition to the recording of picture and program sound, a third signal called *edit sync* is introduced. This signal consists of bursts of about 40 to 50 cycles of 3000-cycle tone at intervals of one second. Interspersed between each burst is an aural identifying count. A master 16mm magnetic film of more than one hour in length and containing this signal has been prepared and is normally played during each recording on a device called the Edit Sync Delayer. By means of the multiple heads on the Edit Sync Delayer, each recorder — the video-tape recorder, the single-system photographic camera and the magnetic sound recorder — has its respective record marked with an identifying seconds beep. The Delayer insures that the marks denote time coincidence on all records. Edit sync is applied to the cue track of the video-tape recorder, the optical track of the kine recording, and to a special 50-mil track adjacent to the program sound on the magnetic sound film.

The Edit Sync Delayer is shown in Fig. 2. The film path of a standard PM 66 magnetic recorder has been altered so as to accommodate the additional magnetic heads in proper position for the delay required. Added flexibility has been provided in the device so that each of the heads may be arranged for either record or playback. This feature is used, for example, if subsequently additional 16-mm kinescope recordings are to be made by transfer of Edit Sync and picture from the previously recorded video tape.

Here the edit sync, previously recorded, bears a significant relationship to the picture but requires additional delay before being fed to the photographic camera. This is readily obtained by threading a fresh roll of magnetic film into the Edit Sync Delayer, and using the appropriately spaced pair of heads to record and playback.

During editing operations, the 16mm kinescope recording serves as a work print. The editor proceeds in generally the manner employed with other motion-picture work prints and associated magnetic soundtracks using, more or less, the conventional tools and equipment — editing machines, synchronizers, splicers, rewinds, etc. Video tape, as such, is not involved in this phase of the work. By means of the edit sync it is possible to

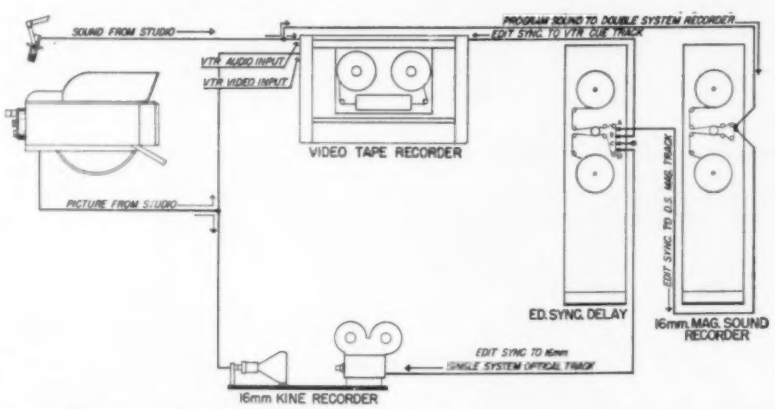
SOUND FROM STUDIO
PROGRAM SOUND TO DOUBLE SYSTEM RECORDER
EDIT SYNC. TO VTR CUE TRACK
VTR AUDIO INPUT
VTR VIDEO INPUT
VIDEO TAPE RECORDER
PICTURE FROM STUDIO
EDIT SYNC. TO D.S. MAG. TRACK
ED. SYNC. DELAY
16mm. MAG. SOUND RECORDER
EDIT SYNC TO 16mm SINGLE SYSTEM OPTICAL TRACK
16mm KINE RECORDER

Fig. 1. Equipment installed in NBC Studios for double-system recording and editing operations. Legend for Ed. Sync. Delay: A, Reference; B, Ampex; C, 35mm; and D, 16mm-RCA.

Presented on October 9, 1959, at the Society's Convention in New York by Oscar F. Wick, National Broadcasting Co., 3000 W. Alameda Ave., Burbank, Calif.
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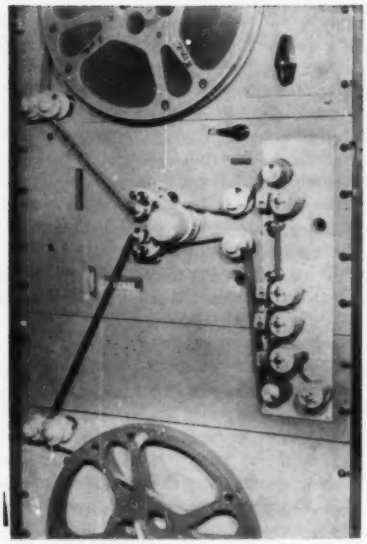


Fig. 2. Edit Sync Delayer.

establish sound sync at any point. The edit sync beep and count may be read by the several special readers provided.

Locating Cut Points

Figure 3 shows a reader for both program sound and edit sync on the 16mm sound record. It is possible to locate precise cut points rapidly and accurately with these devices. Actually, the edit sync signal provides a reference on all records quite similar to that provided by printed edge numbers. Printed numbers, as such, are not practical with the present nonperforated video tape because tape speed is not a precise constant.

As indicated above, the normal procedure is to treat the editing operations as though video tape were not involved. Editing the work print and soundtrack continues to the point where all concerned are satisfied. Usually, a final

Fig. 3. Reader for program sound and edit sync on 16mm sound record.

composite track is then made containing those modifications and additions considered desirable. When a final check indicates this is to be in order and compatible with the edited picture, the creative phase of the editing operation is deemed to be at an end. At this point, the video-tape cutter retires to the relative quiet of his cutting room with the necessary taped segments and a precise log of all cuts to be made. This log is compiled during the editing of the work print. He then proceeds to make the cuts and splices in exact accordance with logged directions. Here again a special reader has been designed to facilitate the rapid location of precise points on the tape indicated by edit sync (Fig. 4). Special hand-type rewinds (Fig. 5) move the tape through the reader. The splicer is a modified Ampex unit.

To provide a means of locating precise frames between successive edit sync bursts, an interpolating rule has been devised with 24 divisions in 15 in. to indicate equivalent work-print frames on the video tape. If the cutter's log calls for a cut at, say, 3:42 plus 4, he would locate 3 min 42 sec by reader, develop out the burst, lay the rule down on the tape, and measure out 4 frames beyond the burst. The nearest frame pulse to the spot indicated by the rule would denote the location of his cutting line.

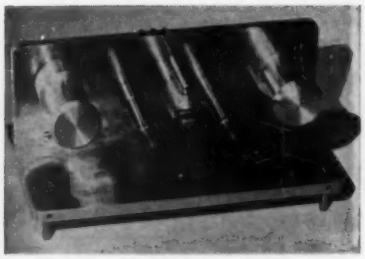


Fig. 4. Reader specially designed for indication of points on tape indicated by edit sync.

It should be stated that the editing is invariably done with frame pulses (Fig. 6). Tests have indicated that undesirable horizontal disturbances occur when noninterlaced fields are spliced together; consequently, the probability of "smooth" splices is less when field pulses are used. In our installation, frame pulses applied by all recorders represent the same field.

The cutter proceeds to make each cut and splice indicated in the log. When this has been done, he attaches sync leader to the head end of the completed reel and to the head end of the final composite track. Sync leader consists of approximately 3 min of identical edit sync recorded in the normal program soundtrack of a piece of video tape and a piece of 16mm magnetic film. When these are attached to their respective reels, due allowance is made for the 9¼-in. sound-picture offset. He is then ready to make the final sound transfer.

In preparing to make the transfer, both the reproducing magnetic recorder and the video-tape recorder are threaded at points near the start of the sync leader — the exact spot on each being determined by the known time of acceleration differences between the two machines. In this way, approximate sync is established when the machines are

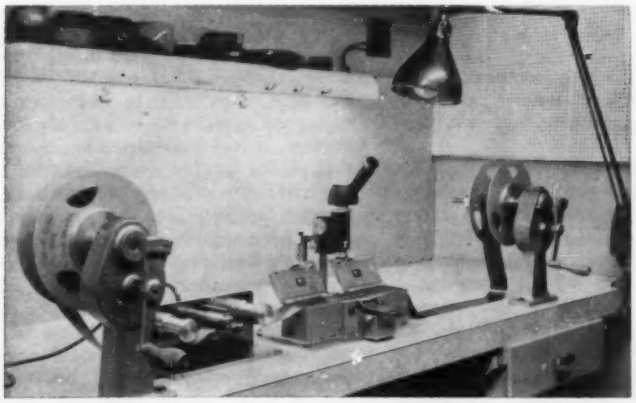


Fig. 5. Rewinds for moving tape through the reader.

Fig. 6. Frame pulses of Edit Sync System. Edit sync is here shown recorded in the audio track — an alternate to the cue track.

Fig. 7. Induction alternator used for driving sound recorders and kine recording cameras at color field frequency.

started and precise sync easily attained during the 3-min period in which sync leader is available. The operator achieves precise sync by listening to the "beep and co[illegible]" signal from the two tracks on bi[illegible]ad phones and adjusting the phase of the magnetic recorder by differential transformer until precise coincidence is obtained. The edit sync signal has been found satisfactory for this purpose.

Once exact sync has been achieved and before all of the sync leader has run through, the operator switches the video-tape recorder to record sound only. He then continues to monitor picture and sound while the actual transfer is in progress. If all splices are made carefully in accordance with directions, no problem with sound sync is encountered. Inherently the video-tape recorder and magnetic recorder will remain locked together since both are driven from the same timing reference. Normally, with monochrome, this would be derived from the 60-cycle power line.

It should be noted that with double-system recording, the video-tape recorder's timing reference takes on new significance. It is essential that this is always related directly to the timing reference driving the sound recorder, otherwise drift will make it impossible to maintain sound sync. In order to perform these operations with color signals, it was found necessary to obtain sufficient power to drive the sound recorders and kine recording cameras at the precisely controlled 59.94-cycle color field frequency. An induction alternator, specially designed and manufactured by the W. R. Turner Co., of Los Angeles, is used for this purpose.

The device (Fig. 7) supplies 5 kw of regulated power at a frequency closely controlled by vertical drive signals from the color sync generator.

These are some of the salient features of the system in current use at NBC. It should be noted that, except for the original recording and the final sound transfer, all editing operations are performed on relatively inexpensive equipment; also, that the handling of recorded video tape is minimized. The *Bob Hope Shows*, *An Evening With Fred Astaire*, commercials for the Chrysler Corp., and several other programs have been handled, during the present season, by the methods outlined.

On the *Bob Hope Shows*, which may be considered typical from the standpoint of technical requirements, two separate picture channels are normally recorded. One of these is fed from a single close-up camera, while the other represents the switched composite studio output minus the close-up camera. Since it is standard procedure to record double for protection purposes, intercutting relationships under these circumstances must be maintained among four recorders. On the average one-hour program, approximately 50 splices are used to make the final master tape. This is then re-recorded to provide broadcast protection.

The procedures in current use appear quite practical and effective. We hope, as our experience increases, to improve and simplify them. Also, it is hoped that this paper may stimulate others, especially equipment manufacturers, to investigate the possibilities and requirements of double-system methods of video-tape recording.

A Special-Effects Amplifier for Noncomposite or Composite, Monochrome or Color Television Signals

By RALPH C. KENNEDY

A switching circuit has been designed to produce a doublet impulse transition of 0.05 μsec. The problem of clamping a color signal during the burst interval by means of crystal diodes is discussed and a solution presented. Nonlinear amplification of the switching data prior to regenerative clipping has been found to permit dependable switching with much smaller brightness changes.

Upon the introduction of special-effects techniques for monochrome television in the late thirties, there evolved two philosophies concerning the proper location in the system at which the synchronizing signals should be combined with the video signals. One thesis has contended that the two signals should be united as soon as possible, preferably in the camera, while a second one has advocated the addition of the synchronizing pulses to the video information after the studio switching operations have been completed. The latter method has been very widely accepted by the networks and local stations and until now it has been almost universal in its adoption.

Color television, due to its compatible nature, has been processed the same as monochrome wherever possible and as a result, the addition of synchronizing pulses has also occurred after camera switching.

When NBC began planning the new studios for Washington, D.C., it was decided to build the plant upon the concept of composite signal switching for both monochrome and color signals. There appeared to be many advantages from such operation: greater flexibility could be realized; studio timing problems were simplified; and less equipment was needed. This added up to reduced space, air conditioning and power. Naturally all the equipment associated with the creation of special effects had to be capable of handling the higher signal level when synchronizing pulses were present. There were in addition, however, many other problems which had to be solved before composite operation could be as flexible as noncomposite. Further, it was immediately recognized that all the new apparatus in order to be universally applicable would have to function properly with both composite and noncomposite signals. With the above considerations kept in mind, the several systems components were appraised. From this survey, it became apparent that a new special-effects amplifier would have to be designed since the existing equipment did not adequately satisfy the new requirements.

Presented on October 7, 1959, at the Society's Convention in New York, by Ralph C. Kennedy, National Broadcasting Co., RCA Bldg., Radio City, New York 20.
(This paper was received on September 21, 1959.)

Possible Circuit Improvements

The heart of any special-effects amplifier is the fast-acting switch. One type

of switch[1] had been in use for several years and it was decided to see if any improvements might be made in it. Clamper diodes had been vacuum tubes, so it was decided to try to see if any of the new semiconductor diodes could be adopted for this purpose. Switching pulses had been shaped previously by regenerative clippers. Investigation showed that there might be other ways that could possibly prove to be superior. This was to be given further study. All of these facets and indeed any others which could effect improvements on previous amplifier designs were to be incorporated in the new unit.

Amplifier Description — Input Stages

The investigation has resulted in the amplifier shown in Fig. 1. The two program signals to be switched are fed to two identical feedback amplifiers V1 and V2. The input goes to the triode half of a 6U8A and the pentode half acts as the output stage. Such an arrangement permits wideband interstage gain due to the reduced Miller capacity of the pentode. These two stages have approximately 15 db of feedback and a gain of 2. The impedance seen looking in at plate 6 of the 6U8A is 100 ohms. High-frequency compensation is obtained by proper adjustment of condensers C22 and C23 while the gain is adjustable by means of potentiometers P1 and P2.

Clamper Considerations

The output of V1 and V2 is fed to the halves of 6922-V3 connected as cathode followers. The grids of V3 are clamped so as to establish proper signal references for d-c coupling to the video switch. The clamper diodes are Hughes 1N625 and 1N191 crystals connected in series. The reason for using two diodes may be understood if one considers the requirements for a clamper diode. First, the diode must have quick recovery from the conducting to the nonconducting state. Second, it must have a very high back impedance and very low forward impedance. Third, it must have a very low capacity so as not to cause undue shunting at high frequencies.

Silicon junction diodes, e.g., the 1N625, meet the fast recovery time requirement (400 K ohms in 1 μsec) as well as having the low forward and high back impedance characteristics. These resistances are about 200 ohms and 20 megohms, respectively. However, the capacity of the junction is about 20 $\mu\mu$f which is much too high. On the other hand, the 1N191 is a germanium point contact diode having a capacity of 0.5 $\mu\mu$f, a back resistance of a megohm and a recovery time of 3.5 μsec to 400 K ohms. By using one of each in series, an entirely satisfactory element for clamping color signals may be obtained.

Composite color signals must be clamped during the burst interval. Since the clamping action results in essentially short circuiting the signal path, there must be a means provided to preserve the burst. This is accomplished by use of antiresonant circuits comprising L1C27 and L2C28. The coils of each are adjusted so that the clamp pulse as viewed at TP-13 has a minimum of burst sine wave on its peak.

As has been pointed out,[2] the optimum time constant for video clampers is 2.5 μsec. This is the product of the impedance of the clamper driver plus the clamper diode impedance times the capacity of the clamper condenser. The output impedance of V1 and V2, the clamper drivers, has already been given as 100 ohms. The forward impedance of the 1N625 and 1N191 diodes are about 200 ohms each so that the total resistive component of diodes and driver is about 300 to 400 ohms and the clamper condenser is therefore about 6800 $\mu\mu$f.

Switch Considerations

The desirable features which are found in semiconductors appeared encouraging enough to warrant investigating their use in the switch. The Hughes HD-2109 has proven to be acceptable in all respects. It has the fast recovery time and low forward impedance required. The back impedance is rather low and the capacity is somewhat too high. However, 40-db rejection in the off mode is sufficient and the diode meets this requirement satisfactorily.

In order to be able to balance out the switching component, a sample of the switch pulse which appears on the grid of V5 is injected in the same phase on its cathode. By properly adjusting the Black Balance Potentiometer P3, the switching pulse may be degeneratively neutralized so that none remains. Similarly, the capacity C34 may be adjusted for optimum transitional symmetry which approaches the unit doublet impulse very closely. The elapsed time for peak-to-peak excursion of the doublet impulse response is less than 0.05 μsec (see Fig. 2) and the amplitude is approximately 3.5% of the signal amplitude.

Output Amplifier

The plate of the 12BY7A-V5 amplifier drives a two-stage feedback output amplifier. The 404A-V6 amplifier is d-c coupled to the shunt regulated[3] output tube 6BX7-V7. This stage is noninverting and as a result, the feedback is to the grid of V6. Without feedback, V7 has a terminated impedance of approximately 30 ohms. With the feedback loop closed, the resulting 18 db of feedback lowers the output impedance to approximately 3 or 4 ohms.

Switch Driver

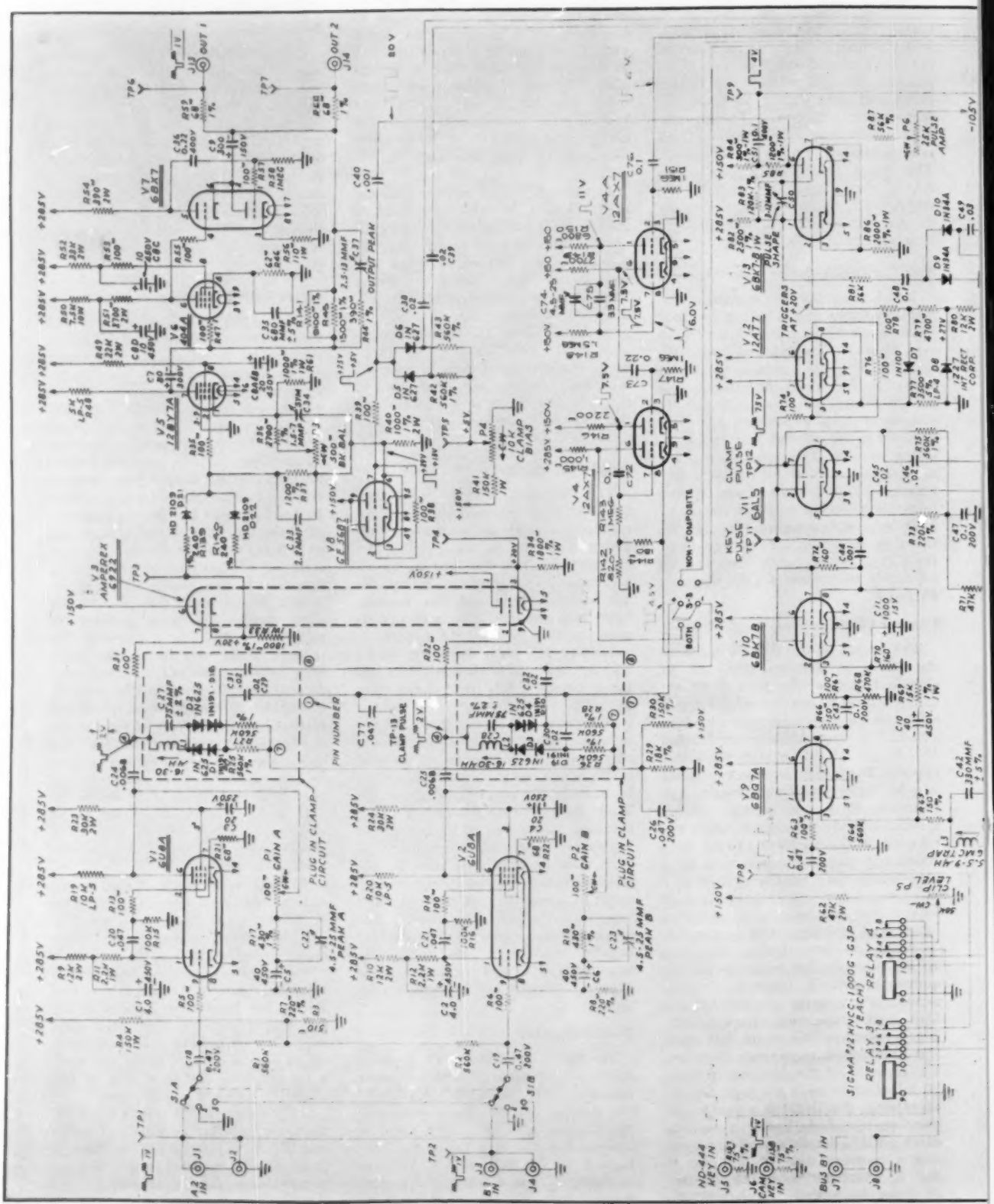
A cathode follower 5687-V8 is used to actuate the switch. This stage has its grids clamped so as to maintain black balance in the switched output signal. Clamper diodes D5 and D6 are Hughes type 1N627. These are biased to +5v. With a 20-v keying or switching pulse at the grids of V8, the switch changes modes between +13 v and +29 v. With no pulse applied, the voltage on the cathodes of V8 is at +13 v and signals from input A2 appear at the amplifier output.

Switch Pulse Processing

The techniques of reshaping pulses are well known in the art and require no elaboration. However, the techniques for shaping the waveform from a television camera are an entirely different matter and require considerable effort to assure success. First of all, the output signal of the camera has high-frequency picture data and noise in it which tends to camouflage the desired pulse. Second, very few camera tubes have flat landing. Instead of having a uniform signal output from beginning to end of each line or from top to bottom of each field when scanning a flatly lighted white area, they tend to have greater output in the middle of the scene than toward the edges thereby producing a waveform somewhat resembling a haystack. To produce a flat top rectangular pulse from such a waveform is indeed very difficult. Admittedly, shading may be introduced in an attempt to correct matters but the degree and form of the shading introduced are dictated by the appearance of the picture rather than by the appearance of the resultant pulse to be used for operating the switch. The usual shaping technique is to amplify the signal greatly, clip out a small segment, and amplify it sufficiently to drive the switch.

The success or failure of such a procedure depends on whether the portions of the line scan which are supposed to be black have smaller noise spikes going toward white than the amplitude of the scan at the end and beginning of blanking. If such be the case, it is obvious that a thin band exists parallel to the direction of scan where no signal data exist. If means are available for clipping off all data above and below this area, a suitable switching pulse may be obtained by sufficient amplification.

If the above condition does not exist, there are two possible situations which may occur. An attempt may be made to move the clipping level or thin slice up toward white. The spikes rising from the black area toward white will be deleted but the edges adjacent to the end and beginning of blanking will



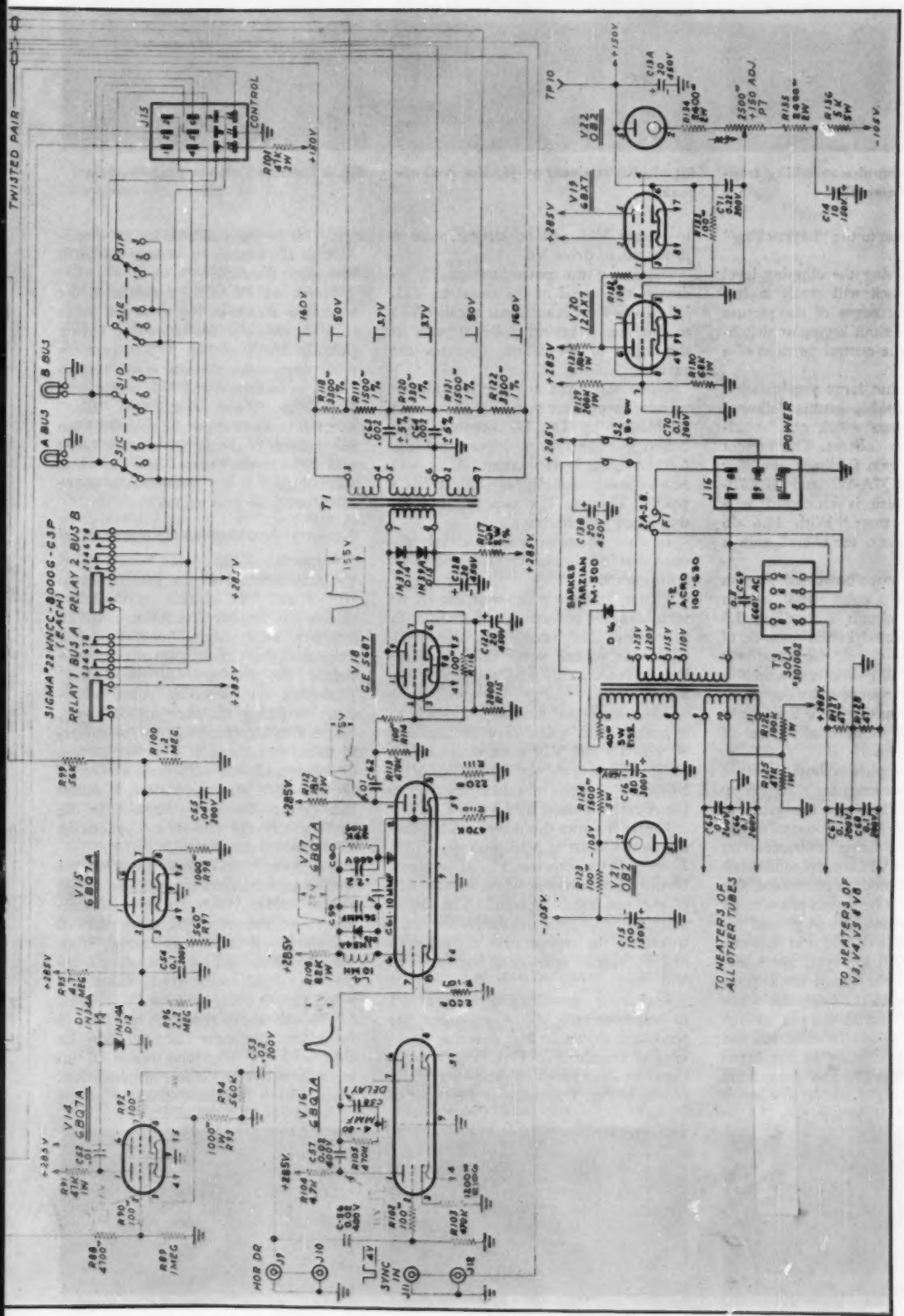


Fig. 1. Diagram of the amplifier circuit.

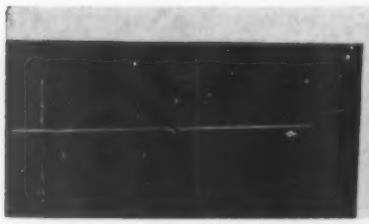


Fig. 2. Doublet impulse switching transient at output of amplifier.

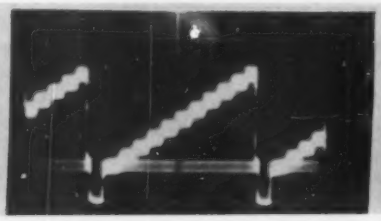


Fig. 3. Input signal at J5, 1 v peak-to-peak.

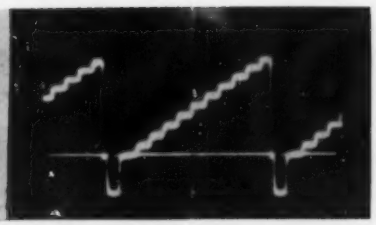


Fig. 4. Input to V12, 80 v peak-to-peak.

become ragged due to the "haystacking" mentioned earlier.

Conversely moving the clipping level down toward black will result in improvement at the edges of the picture but will cause spurious keying or switching to occur in the central portions of a picture.

It is obvious that large amplification of the camera signal is essential followed by suitable clippers which can be adjusted for picture content. The present unit has a high gain feedback amplifier consisting of 6BQ7A-V9 and 6BK7B-V10 each of which is connected as a shunt regulated stage.[3] With 18.6 db of negative feedback, the overall gain is approximately 80.

In order to remove burst and chroma components from a color signal, a high Q antiresonant circuit comprising L3 and C42 is connected in the cathode of 6BQ7A-V9. This circuit degeneratively reduces the overall gain of the amplifier at subcarrier frequency by approximately 27 db resulting in a luminance signal which is substantially free of chroma components.

This signal is applied to both halves of 12AT7-V12 whose grids are clamped by 6AL5-V11. The bias on the grids of cathode follower V12 is controlled by means of the "Clip Level" Potentiometer P5. The output of V12 is coupled through diode D7 whose anode is referenced to a potential of +27 v by means of the zener diode D8. Thus when P5 is at ground potential, the cathode of V12 is at approximately +12 v. All the sync, black and gray portions of the signal are clipped off in the grid of V12. Only the white portions of the signal appear at the cathode of V12. Diode D7 conducts and the same signal appears as the input signal, to 6BK7B-V13. The magnitude of signal, however, is not large enough to trigger V13 and no output pulse is produced to drive V8.

Increasing the potentiometer P5 increases the signal at the input to V13. When this level is sufficient to cause V13 to operate, a keying pulse appears at the input of V8 which operates the switch.

When the input to V12 is sufficient to raise its cathode potential above that established by D8, D7 becomes back biased and acts as a clipper for any further signal level increase. Thus V12 acts as a negative clipper while D7 is a positive clipper. The two produce the thin "slice" referred to above.

In order to consider more clearly the operation of the circuit refer to Figs. 3 through 9.

Figure 3 shows a ten-step test signal with blanking and sync, modulated with subcarrier, and having a peak-to-peak amplitude of one volt. This waveform is introduced at J5 and appears at the input to V9.

The same signal after amplification to a peak-to-peak value of approximately 80 v in V9 and V10 is shown in Fig. 4 as it appears at the input to V12. Note the absence of subcarrier due to the rejection caused by L3 and C42.

Figure 5 shows the waveform appearing at the input to V13 with the "Clip Level" Potentiometer P5 at ground. Notice that only the white or top step of the test signal appears. The signal amplitude, 3-v peak to peak, is too small to unbias the regenerative clipper V13 and no output appears at the input to V8.

Increasing the clipping level at P5 to approximately 17 v produces the waveform shown in Fig. 6 whose peak-to-peak amplitude is 17 v. This is sufficient to operate V13 and the pulse shown in Fig. 7 appears at the input of V8. This keying pulse having an amplitude of 23 v peak to peak is sufficient to operate the switch.

Increasing P5 to 30 v results in the waveform shown in Fig. 8 at the input to V13 while the corresponding keying pulse is shown in Fig. 9. The peak-to-peak amplitudes are the same, respectively, as in Figs. 6 and 7. It is apparent from Figs. 7 and 9 that the "slice" referred to earlier may be selected from any portion of the signal between black and white levels. Figure 7 is set at white while Fig. 9 is the seventh step above black or in the gray region.

Nonlinear Amplification of Camera Signal

Inspection of Figs. 6 and 8 reveals that the amplification of the camera signal by V9 and V10 is substantially linear due to the negative feedback used. To improve what might be termed the "switching resolution" it is necessary to reduce the thickness of the "slice" producing the switching pulse. Manifestly, reducing the slice to (dE)/(dI), where E is signal voltage for brightness I, might not result in a perfect picture at the output but, with such a pulse, if the switching was not perfect, it would definitely be due to the signal from the camera and not due to the processing in the effects amplifier.

To provide additional gain for the whole signal requires considerable design effort. Further, 80 v to drive the regenerative clipper is far more than is necessary and such high-energy, steep wavefronts contain high-frequency components which may contaminate the video signals being switched.

The alternative approach has been to introduce nonlinear amplification so that only the brightness region of interest is subjected to full amplification. Figure 10 is a circuit diagram of the

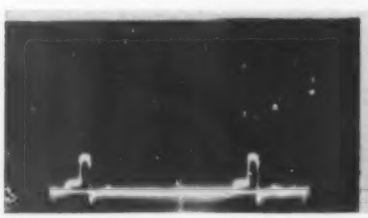


Fig. 5. Input to V13, 3v peak-to-peak, with the "clip level" potentiometer P5 at ground.

Fig. 6. Input to V13, 17 v peak-to-peak, clip level at 17 v.

Fig. 7. Switching pulse at input to V8, 23 v peak-to-peak.

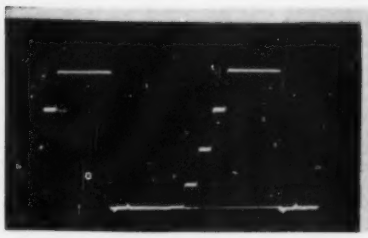


Fig. 8. Keying at seventh step above blanking, clip level at 30 v.

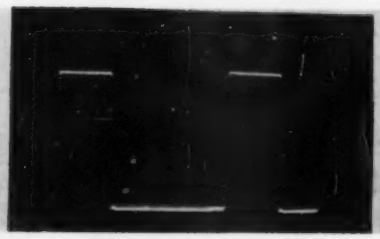


Fig. 9. Keying on seventh step input to V8.

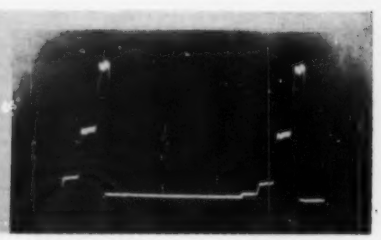


Fig. 11. Nonlinear amplification of signal of Fig. 5.

nonlinear amplifier. This circuit is introduced ahead of the input to V9. The signal is amplified in half of a 6BQ7A from 1 v peak to peak to 2.6 v. This is fed to the clamped grid of a 404A. The cathode resistor of the 404A is 2700 ohms providing high degeneration and resulting in a signal of 2.6 v at the input to 6BQ7A-V9.

The second half of the 6BQ7A is connected as a cathode follower with the cathode resistor of 3900 ohms bypassed with 100 μf condenser and connected by means of two 1N100 diodes to the 404A cathode. The voltage on the grid of the follower and hence that at its cathode is adjusted by a potentiometer.

The amplified signal appearing at the 404A grid is inverted and appears with sync or blanking up and white down. If the follower grid is at ground potential small plate current flows and the follower's cathode potential is below that of the cathode of the 404A, the diodes are thus cut off and the 404A has low gain.

If the voltage on the cathode of the follower is increased by increasing its grid voltage to where the crystals just begin to conduct for the most negative excursions (white) of the signal appearing at the 404A cathode, the 100 μf bypass condenser now shunts the 404A cathode resistor and the gain of the 404A increases several times. Actually gain increases of 8 db may be easily attained. Obviously, this increased gain may be applied to any brightness level of the signal by proper adjustment of the follower grid voltage. Figure 11 shows the effect of such nonlinear amplification in the white region when applied to the signal in Fig. 6.

The improvement realized by such a circuit may be appreciated from the fact that the required change in the "Clip Level" Potentiometer is of the order of five to six volts in moving the clipping level between two adjacent steps when linear amplification is used. On the other hand, the same change in clipping level when nonlinear amplification is used requires two to three volts. Based on such data, it is possible to say that at least a 6-db improvement is possible or that the thickness of the slice has been reduced by a factor of 2.

The situation may be further appraised in the following manner. The input

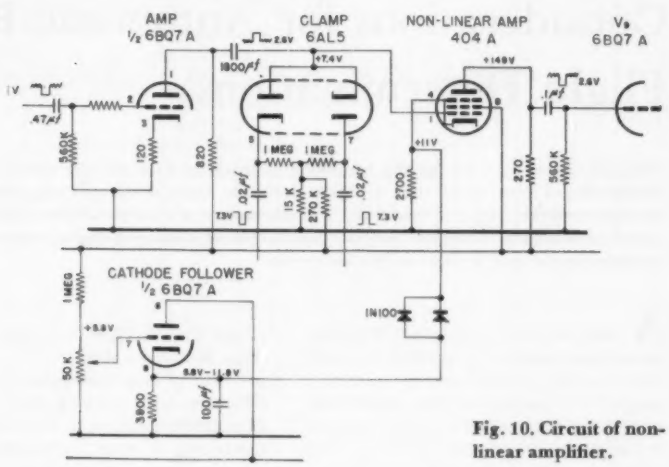


Fig. 10. Circuit of nonlinear amplifier.

step signal having a value of one volt peak to peak contains 0.7 v of video. Each step represents a 10% or 0.07-v change of brightness. With linear amplification, the clip level must be changed approximately 6 v for a change of one step; therefore, the ratio of brightness change to clip level is 0.0117 v to one or 1.67% per volt. With nonlinear amplification, the corresponding values are about half.

Camera Control Tallys

The unit is remotely controlled by means of a cable connecting to J15. The tallys are operated by relays #1 and #2 which are actuated by 6BQ7A-V14 and V15. This circuitry follows conventional practice and it is felt that no further explanation is required.

Clamp Pulse Generator

Horizontal drive introduced at J9 is amplified and shaped by half of 6BQ7A–V16. The clamp pulse, which is developed from the front edge of horizontal drive, may have its delay varied by means of C58. The output of V16 is amplified in 6BQ7A-V17. The plate of the first half consists of a ringing circuit L4 and C59 damped by diode D13. The leading edge of the pulse is negative on the plate which back biases D13 and permits a pulse to appear at the output of V17. The next half cycle which is positive on the plate forward biases D13 causing it to conduct and thus damps out that pulse. The positive pulse at the input to 5687-V18 likewise rings the transformer T1 in a similar fashion, the diodes D14 and D15 damping all succeeding pulses after the first negative excursion.

Pulses of various amplitudes are obtained by the resistive divider R118 through R122.

Voltage Regulator

Several circuits require well-regulated voltage sources. The video clamp pulse generator and the switch circuit require very stable potentials to assure maintenance of black balance in the switched video output. Regulated +285-v power is fed to the unit and additional regulation is provided by 12AX7-V20, 6BX7-V19 and OB2-V22. The circuit uses V20 as a high-gain amplifier. The stage is so connected that variations in the +285-v source appear on one grid while load variations appear on the other grid. The resultant of the two effects are amplified and d-c coupled to the grids of V19 which acts as the "D" tube. A negative reference potential is required (in this case minus 105 v) and is supplied from the circuit using D16 and OB2-V21.

Conclusions

Several of these units have been built and installed, and are in operation in various studios. They have been found to operate very satisfactorily in either monochrome or color installations and plants using both composite and noncomposite video switching.

Acknowledgments

The major portion of the project was completed by John Schroeder, who has since left NBC. Acknowledgment must be made for encouragement and suggestions made by A. L. Hammerschmidt, NBC Vice-President of Engineering and Facilities Administration, and to George M. Nixon, Director of the NBC Engineering Development Group during the course of the investigation.

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Considerations for Automatic Real-Time Flight Determinations

By EARLE B. BROWN

Methods currently used for the reduction of tracking data are extremely costly. Availability of "real-time" data is highly desirable. Capabilities and requirements are discussed for "Super-Theodolite," an automatic, real-time theodolite with three specific techniques: electronic angular measurement, analog-to-digital conversion, and measurement of focal-plane tracking error.

A NEED EXISTS for automated instrumentation capable of providing digitized real-time data of high accuracy on missile ranges. The purpose of this paper is to suggest the integration of certain proven techniques leading to the development of automatic optical tracking instrumentation capable of providing digitized real-time data of high accuracy.

Tracking Instruments

The two main types of tracking instrument presently in use on missile ranges are (1) cinetheodolites and (2) tracking telescopes. The first category includes the Askania and the Contraves E. O. T. S; and the second, the ROTI (Mark I and Mark II).[1]

Trajectory data, obtained photographically by all of these instruments, include azimuth and elevation angles of the instrument line of sight, and the time. The position of the target with respect to the center of the reticle, i.e, the tracking error, is measured on a reader and added to the angles indicated on the scales to provide the actual angular direction of the target at the instant the picture was taken. At present, the time required for data reduction is about eight to ten days.

The Automated Range

An "automated" range would have a cinetheodolite station, operating without human attendance, which would supply accurate trajectory data directly out of the instrument, thus obviating the necessity for data reduction.[2] Data available at the time of flight are called real-time data. Real-time data require the measurement of both instrument line-of-sight direction and tracking error (if any). Accurate transmission, over considerable distances, of data acceptable to computers requires that these data be in digital form.

Unattended operation would be of tremendous benefit in terms of manpower requirements. Many cinetheodolite stations are in almost inaccessible locations and obtaining a sufficient number of tracking operators for all stations is a considerable problem.

The three primary requirements for the cinetheodolite of the automated range are: automatic tracking of the target; automatic digital output of shaft position (azimuth and elevation of the line of sight); and automatic digital measurement of tracking error. These requirements may be met with existing techniques to a degree of accuracy at least as high as that attainable with existing instruments.

The Super-Theodolite

An instrument which may eventually be developed to meet these requirements has been given the name of "Super-Theodolite." Two specific techniques are involved: digitization of shaft position and digitization of tracking error. It is obvious that if automatic measurement of tracking error is possible, then automatic tracking would also be possible.

Digitization of Shaft Position

Our solution for the required digitization of shaft position is the use of the Farrand Inductosyn and of analog-to-digital conversion techniques which have been developed for use with it.

The required accuracy for trajectory measurement is very high: 15 to 30 seconds of arc is now achievable with cinetheodolites; it is desirable to improve this accuracy if possible, and certainly it must not be degraded. Ten seconds of arc may be a reasonable goal for the Super-Theodolite.

A number of shaft digitizers are available, but very few of them have the necessary accuracy capability which, for 10 seconds of arc, corresponds to 17 binary digits. Seventeen-digit units utilizing optical code discs are being built. This seems to be near the limit for this type of device. An 18-digit unit has been constructed for the Inductosyn and with the more accurate components which have recently become available an accuracy of 20 digits is possible. It seems doubtful, however, that an instrument can be realized with mechanical parts capable of maintaining this degree of accuracy.

The Farrand Inductosyn is an electrical angular or distance measuring device consisting of electrical windings deposited on glass plates. It is essentially an analog device. Its utility in a digital measuring system is that it provides data of an extremely high order of accuracy (one second of arc), which is higher than that provided by any direct digital device or by any other analog device operating throughout 360° of rotation.

The electrical windings are in the form of hairpin turns. Conventionally,

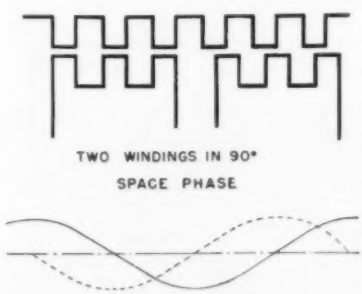

Fig. 1. Schematic of electrical windings and coupling waves of Farrand Inductosyn.

Presented on May 5, 1959, at the Society's Convention in Miami Beach by Earle B. Brown, Farrand Optical Co., Inc., Bronx Boulevard and E. 238 St., New York 70.
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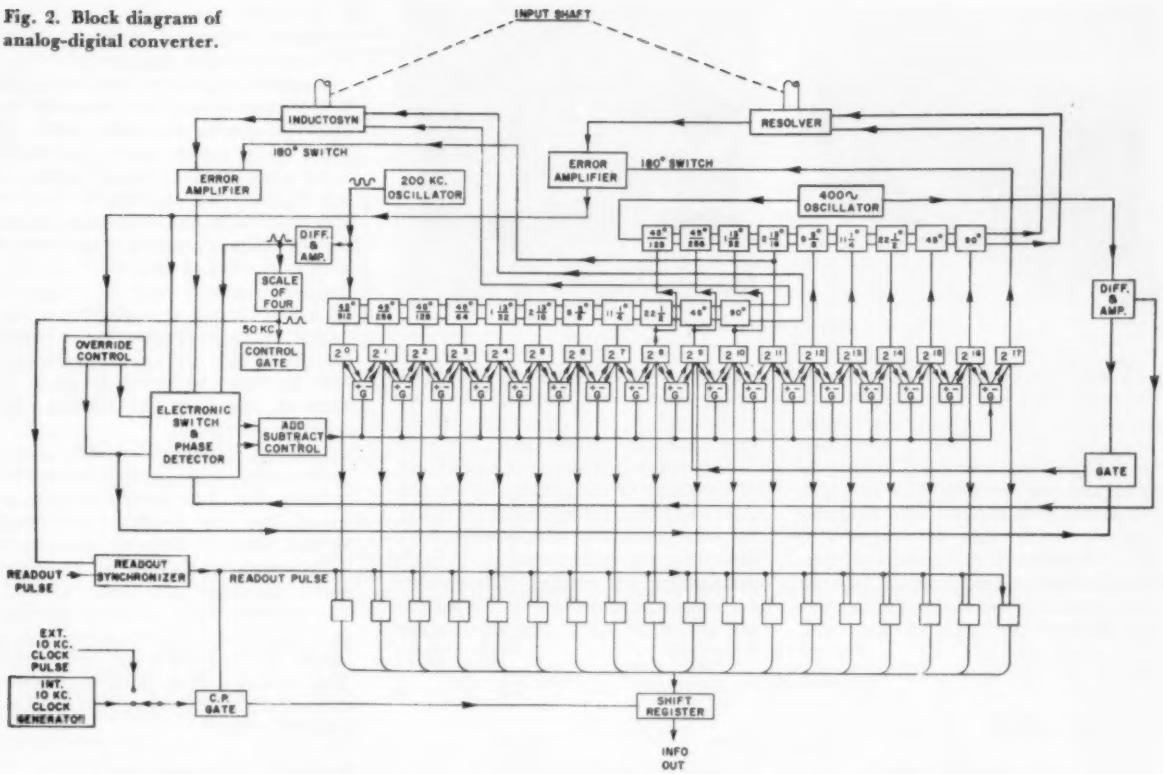
Fig. 2. Block diagram of analog-digital converter.



one disc has a multiple-turn, two-phase winding. Figure 1 shows, schematically, the form of the windings and of the coupling wave between the two discs. The analogy to an electrical resolver is evident. If the two-phase winding is energized by voltages corresponding to the sine and cosine of a given angle, the output from the single-phase winding will be a sine curve of voltage against angular position, with a null at the position corresponding to the input.

Inductosyns are made with various numbers of turns or poles. In the 12-in. unit, which would presumably be used for a Super-Theodolite, there are usually 360 poles, that is, 360 nulls of the rotor output in each complete revolution. To avoid ambiguities, a coarse one-speed data system, utilizing a resolver or synchro, is used with the instrument.

Two methods of approach to the attainment of shaft digitization of 18 or 20 binary digits are: (1) direct digitization of the analog voltages of the Inductosyn and (2) use of the instrument to couple direct digitizers in series. A unit of the first type was developed and delivered to the Air Force in 1955.[3] Figure 2 is a block diagram of this system. It operates on the principle of development of sine and cosine voltages by the operation of a digital counter. These voltages are built up until the rotor output of the Inductosyn is brought to a null. This unit was built before development of the 12-in. diameter Inductosyn. A 3-in. unit was used. This unit proved accurate to about five seconds of arc — barely sufficient to achieve the design aim of 18 binary digits. As delivered, it achieved 17 units of absolute accuracy, thus demonstrating the capability of the technique. This first approach constituted a breadboard system. The electronic complexity of this approach is great and the second approach is recommended for a field instrument.

It is not difficult to construct a small, compact and reliable shaft digitizer with a capacity of seven or eight binary digits and several varieties are available. In principle, two 7-digit units could be connected by a 64:1 gear ratio to provide a 14-digit output. This concept cannot be carried too far. For a 15-digit number, the incremental accuracy is one minute of arc, and at about this point, the accuracy that can be attained in gear trains begins to limit the results.

The Inductosyn provides a means for obtaining a gear ratio without any gears. The output is similar to that of an electrical resolver, but has multiple nulls, therefore a conventional resolver coupled to an Inductosyn will, through a servo drive, operate at multiple speed, thus providing a means for coupling two small digitizers together without losing accuracy in a gear train.

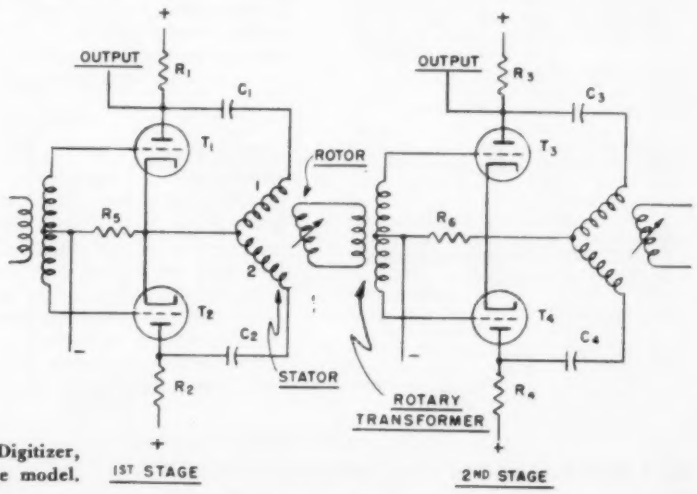


Fig. 3. Digitizer, two-stage model.

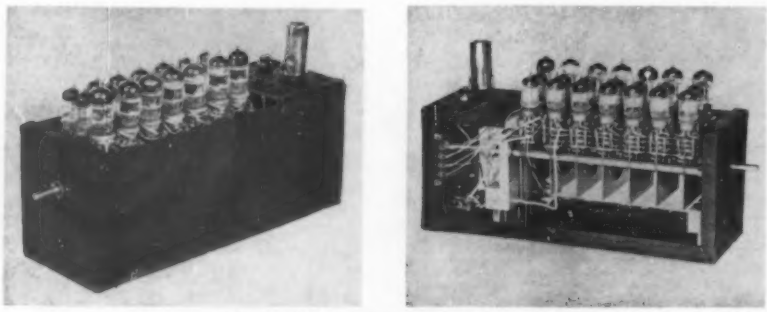


Fig. 4. Digitizer, seven-stage model.

A new type of low-capacity digitizer has been developed which offers some distinct advantages for application to the Super-Theodolite.[4] These advantages are: high-speed operation, absence of ambiguity, high readout rates and high reliability. This digitizer uses inductive coupling rather than commutation to permit high-speed operation and eliminate the contact wear problem. Figure 3 is a schematic of two stages. The measuring elements are pairs of discs with segmental printed patterns which give nearly square-wave coupling. These are connected in the thyratron circuit through rotary transformers. The state of each stage is determined by the state of each pair of thyratrons, one of each pair being conducting, the other cutoff. By principles similar to those which have been discussed in the literature,[5] possible ambiguities are avoided. The state of each stage is controlled by the state of the preceding stage. The whole count is invariably determined by the least significant digit and therefore cannot be in error by more than one bit.

Readout is obtained by applying a pulse to the input circuit, thus firing the appropriate thyratrons which store the count in the system until it is cleared.

An experimental 7-stage model of this digitizer was constructed (Fig. 4) and subjected to exhaustive tests, including 900 hours of continuous operation at a 1000/sec reading rate. There were no component failures and no change in accuracy, which was established at ±1 count. The unit illustrated is a breadboard, and does not appropriately indicate the size in which it could be achieved, especially with transistor circuitry.

This type of digitizer would be used in the Super-Theodolite in the manner indicated in Fig. 5 to provide 18-digit accuracy. Two pulse converter units would be used, one of 6-digit and the other of 7-digit capacity, coupled by an Inductosyn "electronic gear ratio" of 64:1. The six finest digits would be provided by a counter which develops a voltage to match the 64-speed servo error signal. This counter is of the same type as that utilized in the counter type of digitizer described above.

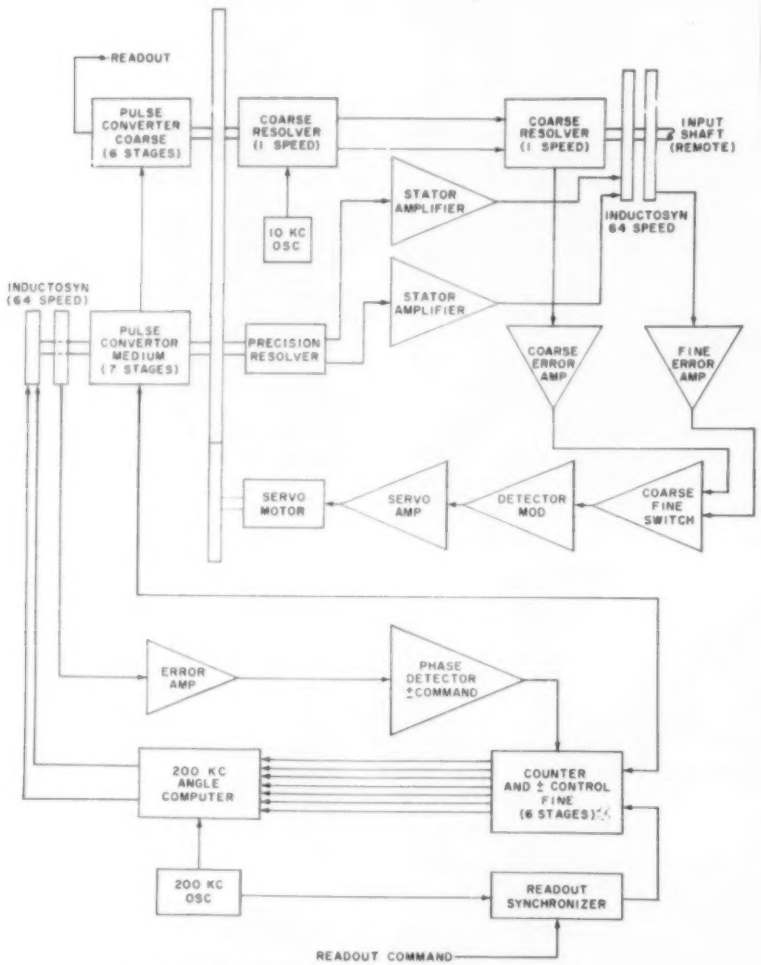


Fig. 5. Block diagram of the system, 18-digit converter.

Digitization of Tracking Error

There are a number of ways in which the automatic measurement and digitization of tracking error may be approached, among them, one- or two-dimensional detector mosaics, binary-coded focal plane masks, digitization of analog signals from optical scanners.[6,7] Our recommendation, based upon the construction of a device utilizing this technique, is digital counting along the scan lines of a television pickup tube. We have used both analog and digital techniques for detecting a target object in a television field of view. Instrumentation of the digital approach is shown schematically in Fig. 6.

The control unit is a master oscillator, which operates a binary counter to represent the distance of the scan beam along the scan line. By deriving the scan itself from this oscillator, synchronization is assured and drift in the channel is eliminated. In the device which has been constructed, the counting rate was 7 mc, which permits a frame rate of about 20/sec for a 500-line picture, or about 6/sec for a 1000-line scan.

The occurrence of the target signal pulse in the video output of the detector stops the count and transfers the accumulated count into a shift register through a transfer matrix. This arrangement is necessary because available forms of shift registers cannot accumulate counts with sufficient speed to operate directly from the oscillator. The transfer from the binary counter is a parallel transfer.

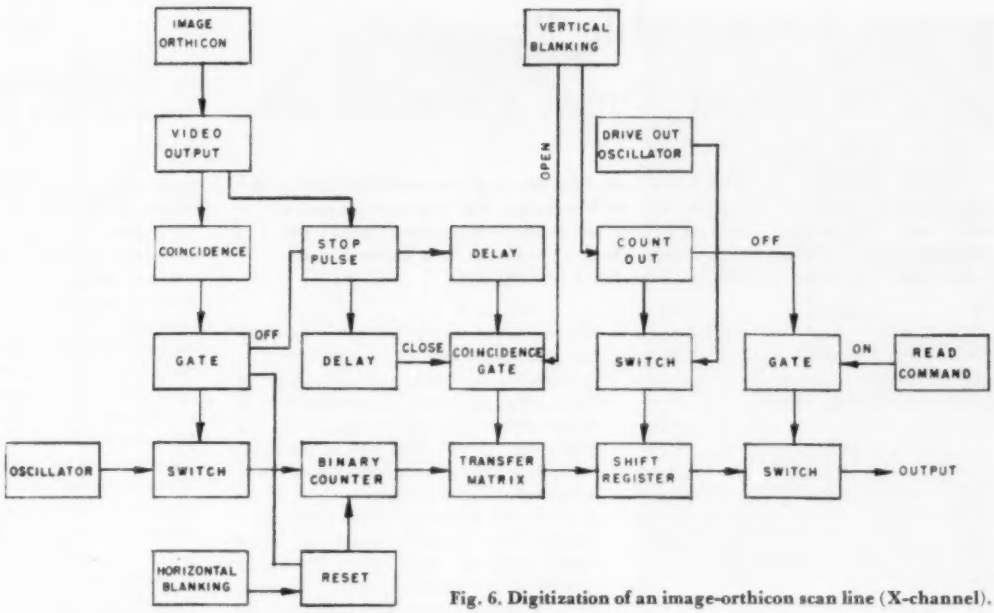


Fig. 6. Digitization of an image-orthicon scan line (X-channel).

A coincidence gate is shown in the diagram, operated from the stop pulse so as to prevent the transfer of a second count into the shift register. This gate is opened after each frame. Thus, the system will indicate the position in the field of view of the first object giving a signal. Various techniques may be used in the video channel to discriminate among targets, especially in night operation, when stars will become targets. With a 12-in. aperture, the system should detect 7th magnitude stars.

To read out information, a drive-out oscillator is provided to clear the shift register of its stored count. This count comes out in serial form, although parallel readout could as readily be provided. The count appears in the output only when an external read command opens the output gate.

Figure 7 shows the corresponding channel for the other direction, in which the scan lines are counted. Here the counting rate is sufficiently low that the shift register can be driven directly from the clock pulses at the end of each scan line. The output section is the same as for the previous channel.

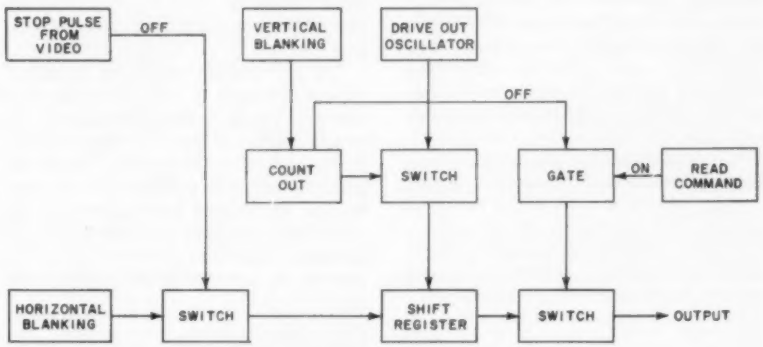


Fig. 7. Image-orthicon line count (Y-channel).

System Characteristics

This system should be used with an optical system of the general scope of the ROTI. With a focal length of the order of 100 in., the accuracy of the tracking error digitization would be about 4 seconds of arc, so that the overall system could provide an accuracy of 18 binary digits, or about 5 seconds of arc. It is possible that mechanical tolerance would limit the system accuracy to 15 seconds or so. This is somewhat better than is presently available with cinetheodolites.

Our experience with television systems seems to indicate that the target discrimination capabilities of such a system, using an optical aperture of the order of 12 in. would be at least as good as that achieved by human operators using available tracking telescopes.

Ranging Capability

The addition of PULSAR Optical Ranging Equipment to the Super-Theodolite would provide capability for ranges up to perhaps 10 miles, using optical retroreflectors on the targets. The accuracies attainable with this equipment are consistent with the positional accuracies defined by 15-sec tracking. Thus it would be possible to have, for relatively short ranges, a single-station trajectory measuring system.

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A New Convertible Projector for 35mm and 70mm Film

By WILLY BORBERG
and BERNARD D. PLAKUN

A projector of basically new design is intended for the dual purpose of projecting either 35mm or 70mm film, at either 24 or 30 frames/sec. The different projection lenses are prefocused in precision fittings for ready interchange. Optical and magnetic soundheads are integral assemblies. Conversion from either film size to the other, and frame rate change, takes but a few minutes.

THE SUCCESSFUL ROAD SHOWING of 70mm films with increased image areas, and as many as six soundtracks, has created a need for a projector which would show both 70mm and 35mm films. The projector to be described, the National "Seventy," is a recent design developed to meet the specific requirements of high-quality projection and sound performance, with reliability of operation, and simple conversion between the two film formats.

The projector mechanism (Fig. 1) had to be made larger, not only for better threading clearance but also to accommodate the wider and higher film frame, the larger sprockets, trap, gate, and particularly the projection objectives with their greater diameters for better light transmission, distribution and finer definition.

The optical clearance throughout this National "Seventy" projector exceeds the requirements of present-day high-output arc lamps, and anticipates future requirements for apertures as large as $f/1.5$. The shutter, a two-blade cone type, intersects the light from the arc at a plane very close to the film in the aperture, to achieve a high light-transmission efficiency. The intermittent mechanism is a Geneva movement with a 90° pull-down. The shutter rotates at frame speed, with two light pulses per frame. Width of the shutter blades is adjustable to permit higher than normal light transmission for drive-in theaters, where some "cheating" may be permissible in view of the generally lower screen brightness levels.

The film trap and gate (Fig. 2) have a curved film path to help stiffen the film frame in the gate, thus reducing the effect of buckle under the often-encountered high light intensities.* Both the gate and the trap have heavy cast-iron frames. The curved film-supporting rails in the gate are formed of highly polished fine-grain cast-iron, a surface which has proven to have excellent sliding and wearing properties. The flexible pressure straps in the film trap, which hold the film against the gate curves, are Teflon with steel backing. Teflon, as a sliding contact surface, is practically self-lubricating and has a stable frictional drag. The gate tension is, of course, adjustable and self balancing. Interchangeable aperture plates are slide-in type, and fit firmly in place in dovetails.

The lens holder (shown in Fig. 1) has received particular attention in this new construction. Its rigidity is such that the heaviest lenses, plus eventual front attachments (anamorphic lenses) are held firmly and vibration-free on the optical axis of the projection system. Each lens is clamped in a tubular adapter. For projecting a 70mm film, where the film center coincides with the optical center, the adapter is concentric with the lens holder. For a 35mm optical sound print, the adapter has an 0.049-in. offset for proper lens alignment on the optical axis. The adapter also serves to position a newly inserted lens at its proper focus distance from the film plane. The focus adjustment knob, below and in front of the lens holder, is calibrated and numbered so that any lens may be considered prefocused after a change has been made.

Unit construction, with both the curved gate and the lens holder carried on the same slide, is a novel feature. After opening and closing the gate, as for threading, the lens returns to its accurate

Presented on October 5, 1959, at the Society's Convention in New York, by Willy Borberg (who read the paper) and Bernard D. Plakun, General Precision Laboratory Inc., 63 Bedford Rd., Pleasantville, N.Y.
(This paper was first received on November 9, 1959, and in final form on January 20, 1960.)

* Willy Borberg, "Effect of gate and shutter characteristics on screen image quality," *Jour. SMPTE, 66:* 623–627, Oct. 1957.

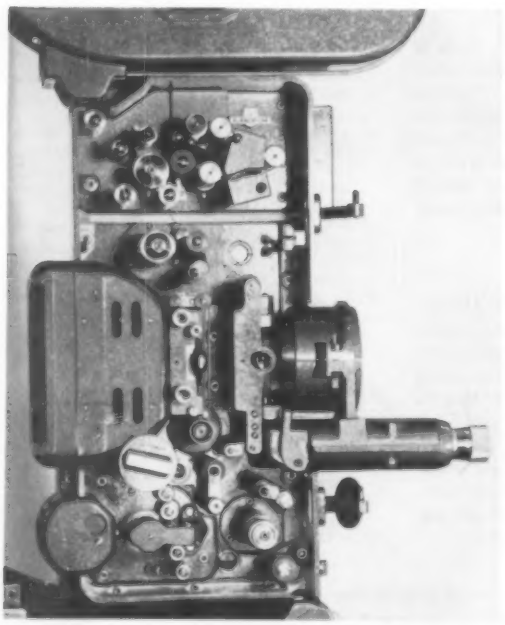

Fig. 1. Operating side view.

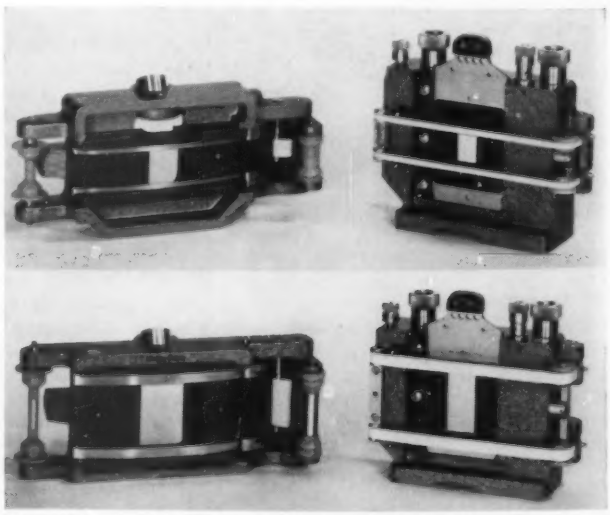

Fig. 2. Film trap and gate sets for 35mm and 70mm film.

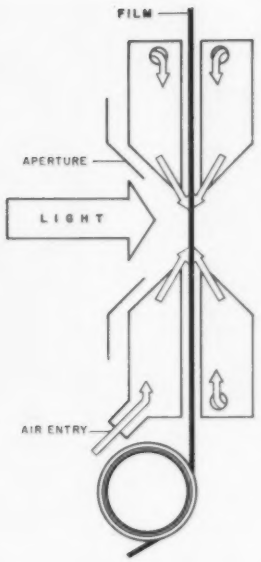

Fig. 3. Cooling air flow through the film trap.

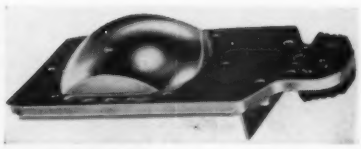

Fig. 4. Aperture lens.

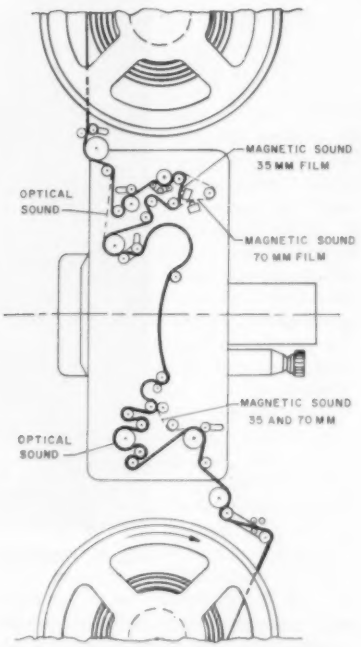

Fig. 5. Threading diagram.

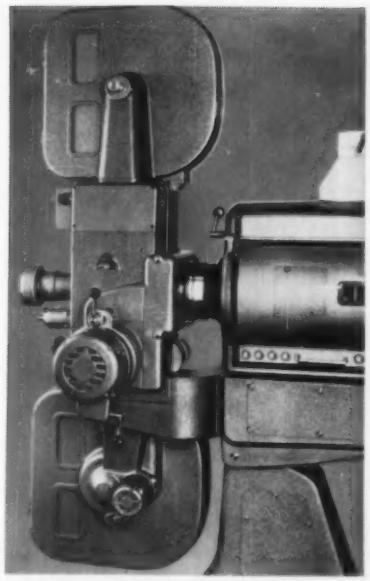

Fig. 6. Nonoperating side view.

focus position with regard to the film plane. The arrangement permits liberal threading clearance between trap and gate, and allows a lens to stand very close to the film. There is practically no limitation on lenses with short back focal distances, as are often found on short-focal-length, wide-angle projection lenses.

While threading the film, its frame position with respect to the aperture opening may be seen through a built-in magnifying lens in the gate. A large hand knob, conveniently placed below the lens holder, can turn over the mechanism to check that the movement is in its locked position, and not engaged in pulldown.

Cooling of the film, the film trap and gate, and the shutter compartment is entirely by forced air. A $\frac{1}{4}$-hp compressor is supplied with each projector for delivering air under about 4 pounds pressure. This air is channeled through the film trap, the aperture plate, and the gate, and escapes from slots surrounding the film frame at the aperture, as shown in Fig. 3. Both sides of the film are thus washed by air. All film contacting parts are effectively kept at a low temperature, and the film itself derives some benefit of cooling.

The shutter housing and its stray light baffles are separately served by a self-contained, low-pressure ventilating system, which operates from a centrifugal exhaust fan on the motor shaft. This fan pulls air through louvers in the shutter housing and expels it on the nonoperating side of the machine.

For use with short-focal-length projection lenses, provision is made for the insertion of an aperture lens (Fig. 4) which will reduce vignetting and improve the screen light distribution and light transmission efficiency. The arc side of the shutter housing is equipped with a slide-in frame into which can be mounted a heat-reflecting filter or a field lens for proper spot shaping at the film aperture. Arc lamps designed for 70mm and 35mm operation do not necessarily require such a lens.

The optical and magnetic sound reproducers are integral parts of the projector head. The film paths are as shown in Fig. 5. A single front compartment door encloses the entire film path of the projector, as well as of these two sound units. The magnetic head assembly has a power-driven sprocket to pull the film out of the feed magazine, through the stabilizer system and past the pickup heads. Separate 6-track and 4-track pickup heads are employed. It is merely necessary to thread the film in front of one or the other. Threading guidance is provided so that the 35mm or 70mm film passes the proper pickup head.

The use of separate heads may result in some saving. It is quite possible that the 4-track cluster may wear out before the 6-track cluster. With separate heads, this cluster can be replaced by itself. In a combined 10-track head, both clusters become useless if one is worn.

By the use of two threading paths, two accurately aligned heads on their own firm mountings are always available. Interchangeable plug-in heads sharing a common position could not maintain good tracking performance because they would have to be changed when going from one to the other film size.

The optical soundhead is of conventional design with rotating gate, flywheel and damping devices. The exciter lamp and photoelectric cell are the same as used in the Simplex systems. 70mm film is not threaded through the lower soundhead, but is by-passed to the take-up sprocket.

Cast aluminum is used on the upper and lower magazines (Fig. 6), for both the cases and the doors. They are equipped with a light for ease of observation. The reel spindles are $\frac{1}{2}$-in. diameter and are ball-bearing mounted to carry the heavy film load of a full 70mm reel. The take-up mechanism has a start assist to keep the film under tension when starting up. The take-up maintains even film tension of about 8 oz from the beginning to the end of the reel. Film capacity is approximately 4500 ft.

The gears and shafts of the mechanism, the intermittent movement and the framing device are enclosed in the main frame housing for protection and to permit splash lubrication (Fig. 7). Oil is circulated for adequate lubrication, with one indicator for oil level and another for flow, both visible from the operating side. The oil used is a standard automotive type, readily available in any locality.

The drive motor is synchronous and is mounted to the main frame on the nonoperating side. A very simple device (Fig. 8) has been worked out to change

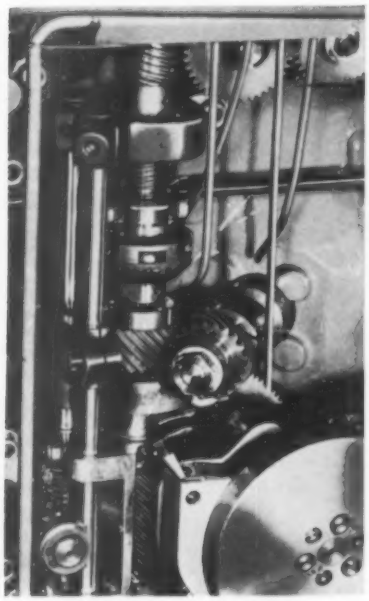

Fig. 7. Nonoperating side view, cover removed.

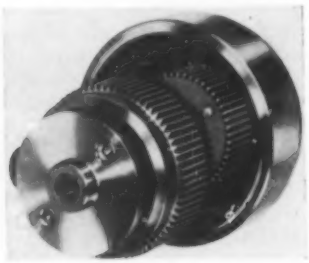

Fig. 8. 30-frame to 24-frame speed change device.

the mechanism speed from 30-frame to 24-frame, or vice versa. This is done by means of an internal gear on the mechanism side, which at 30-frame speed is engaged by an external gear of the same pitch diameter, so that both gears work like a clutch, and have a transmission ratio of 1:1. At 24-frame speed, the motor is simply moved out and over, and a smaller external drive gear engages the internal gear. The speed reduction results in 24-frame operation of the projector. Conversion requires merely loosening two hand knobs and moving the motor mount to a preset position.

To convert the mechanism from one film format to another requires about three minutes. Since no dual-purpose sprockets are used, the sprockets are interchanged. Each is securely clamped to an expansible shaft by one screw at its shaft center. This method avoids needless replacements due to unequal wear, as could happen with dual-purpose sprockets. In the case of the intermittent sprocket, it has the extra advantage of minimum inertia load on the starwheel, resulting in better steadiness and less wear.

The pad rollers are not changed, but are merely swung to new centers on eccentric locating studs. The film trap and gate assemblies are exchanged for their corresponding pair, and resilient fittings automatically join the air passages. All interchangeable parts are color coded to indicate to the projectionist whether the equipment is ready for 35mm or 70mm film.

Figure 9 shows the assembled projector, with magazines and arc, on its pedestal. The projector may be tilted down about 21° and upward 12°. The tilt pivot is high and well forward on the pedestal, as in conventional 35mm projector mountings. An adjustable bracket between lamp table and arc-lamp housing allows the arc to be moved in three directions, for correct alignment with the optical path of the projector.

Fig. 9. National "Seventy" Projector installed.

The equipment is manufactured for the National Theatre Supply Company by the firm of Eugen Bauer of Stuttgart, Germany. It was designed by Christian Wacker, their chief engineer for new developments.

Discussion

John Hayes (Bausch & Lomb Optical Co.): What is the curvature of your film gate?

Mr. Borberg: The curvature is about 12 in.

Mr. Hayes: That's the same for both 35mm and 70mm?

Mr. Borberg: Yes.

Simultaneous Theater Reproduction of Four Languages

By LORIS M. GARDNER

Presentation of the scientific films which were prepared for the Atoms for Peace Conference at Geneva required multilingual sound. In order to provide a sophisticated performance, a four-theater complex was planned to present each film with simultaneous sound in the four official languages. Planning which led to the selection of the method is discussed.

IN ARRANGING AND PREPARING the films presented at the Atoms for Peace Conference in Geneva, a strict dividing line was drawn between films for entertainment and scientific films. It was felt that any attempt at entertainment would detract from the serious purpose of the technical films. Effects were used only for the purpose of enhancing or clarifying the content of the film and the use of music was limited to title and finale. Each film was carefully inspected to make sure of the scientific accuracy of the content.

The films program covered such general areas as reactor technology, high-energy particle accelerators, and controlled fusion. Most of the films dealt with reactor technology and covered such subjects as fuel fabrication, research and power reactors, medical reactors, chemical processing, tracer diagnostics, brachiotherapy and teletherapy. A 30-min film told the story of the high-energy accelerator program in the United States, and a 55-min film on controlled fusion, based upon the Sherwood program, told the story of controlled-fusion experiments in America.

The selection and preparation of 45 films (90 reels) within a year demanded detailed planning. It was necessary to schedule reviews close to deadlines in order to assure that the films were suitable for showing at Geneva. The following steps were used in review: review of outline and rough script; review of narration script; check of the rough cut; check of the answer print; and final reproduction and sound transfer.

Special attention was paid to the visual and narration script. Each script was reviewed by a technical advisor either from the Atomic Energy Commission or from the staff of one of the National Laboratories. One of the members of the film branch worked with the advisor on the reviews. In unusual circumstances, where borderline information was involved, the technical director of the Office of International Conferences reviewed the script, the rough cut, or the answer-print. These were detailed reviews, in which words were weighed and paragraphs often rewritten to correct faulty narration. During the period of rough-cut check and answer-print check, it was necessary for film branch personnel and the technical advisers to travel widely. Some of the best material originated on the Pacific Coast and was reviewed there. In many cases makers of the films were requested to make last-minute changes, and the transmission delays were frustrating, but the producers all cooperated to a remarkable degree.

As originally planned, the release print preparation would have been identical to that used in the first Conference at Geneva. By this method four release prints were made and each optical soundtrack contained a translation of the narration for the film in one of the four official United Nations languages. This plan was discarded because of the expense of four release prints, plus back-up prints in each of the languages, and also because the use of an integral or interlock sound technique would increase the film showing per minute of viewing time by a factor of three. It was decided that an integral or interlocked system would be economical and, at the same time, achieve a higher degree of sophistication. An internationally recognized expert, Ellis D'Arcy, was retained to survey the field and to make recommendations. His basic recommendations were used as outlined below.

The General Plan

First, a 35mm projector was to be provided for projecting color release prints with conventional CinemaScope magnetic striping, the sound record being reproduced by a CinemaScope penthouse head. Four small theaters were planned, seating about 12 to 15 people. According to the plan, the projector would beam the visual via a front-surface mirror upon a back-projection screen of a special design and the language could be selected by the viewer by means of selector switches installed in a chair-side pillar. The volume could also be controlled from the chair. The only major change from the original suggestions was the substituting of 16mm for 35mm projection, and the use of an interlocked rather than a single system. This change was made necessary because of the cost of enlarging many existing films from 16mm to 35mm and, since the screen would have a maximum area of 30 in. by 40 in., the resolution gain from the 35mm format would not be fully realized. For these reasons, it was decided to use 16mm methods.

The field was surveyed to discover methods which were presently available to provide an integral language reproduction with the visual of a 16mm film. The use of the new multitrack integral system devised by Auricon was suggested. A prototype system, consisting of a four-channel magnetic soundhead fitted to a JAN projector and driven by a four-channel amplifier was demonstrated. The four-head sound system operated within the width of the normal 100-mil stripe on the 16mm release Kodachrome print. The system worked well, and, if it had not been that it was, at that time, a prototype it would have been selected for use overseas. It was considered risky to use a prototype system in a site remote from the producer of the system.

It was finally decided to interlock a projector and a magnetic film reproducer, which would have four languages recorded upon it and four heads reproducing. In the ensuing months, Magnasync Manufacturing Co. made four reproducers and one recorder-reproducer interlocked with RCA projectors. The system was engineered by the Lytle Corp. which also contracted to provide operation and maintenance at Geneva.

Presentation

Two types of scientific films were planned for the Atoms for Peace Conference. First, there were "program"-type films that were presented to the United Nations for their showing in their Salles de Cinema. Ranging in viewing time from 20 to 55 min, they were planned as a survey of the entire subject rather than a study of a detail or process. By an arrangement with the UN, the four-channel sound reproduction was used in these films, as well as in the shorter films which were to be shown as one of the United States exhibits. The UN asked that the office of the International Conference establish a standard which would define the parameters of the four tracks upon the magnetic film. In cooperation with Lytle and Magnasync, this standard was established so that the films prepared in the United States and recorded upon the United States recorder, could be played back upon the United Nations re-

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Presented on May 6, 1959, at the Society's Convention in Miami Beach by Loris M. Gardner, Photographer, 513 Atterdag Rd., Solvang, Calif. (formerly at Edgerton, Germeshausen & Grier, Las Vegas, Nev.).
(This paper was first received on May 7, 1959, and in final form on December 29, 1959.)

producer. In spite of the fact that the UN machine was procured from a different source, arrangements with Stancil-Hoffman Co. insured that the recorder and reproducer matched. As it turned out, the sound reproduction resulting from the use of this method in Geneva was very satisfactory. Other nations supplied their films narrated in their own languages.

The UN used an interesting method in interpreting and translating the narration from the films of other nations into the four languages. They were all recorded at the same time on the four tracks as a simultaneous interpretation. Four interpreters, provided with a reference script, viewed the film and interpreted the narration as if they were interpreting the speech of the speaker on the podium. This was quite successful, although a time lag was apparent.

It is pertinent at this point to mention that the Russian exhibitors prepared five-track CinemaScope film in English, French, Russian, Spanish and German of their presentations on 35mm film and provided two 35mm American CinemaScope machines. During its first testing, it became apparent that the perforation on the film did not accurately match the sprockets in the penthouse head, causing multiple breaks in the film and tie-ups in the machine. Howard Tremaine, acting as our expert in Geneva, was able to help indicate a solution for this problem.

Since the UN had many films to present, a three-time showing of each of the films during the period of the conference was all that could be assured. Later, additional showings of these films were requested, and with permission of UN authorities we obtained the films and showed them in our own four small theaters.

The four theaters extended across a short side of the balcony of the exhibit hall. Each contained 14 chairs, each chair equipped with a control box on a pillar. This control box allowed the viewer to select any one of the four official languages, and to adjust volume of the track. The headphones were the conventional type, such as are used in radio work, so that complete exclusion of room noise could be obtained. The theaters were well designed and the chairs were comfortable. Back-projection screens provided brilliant high-resolution pictures. The projection rooms were staffed by four men and a supervisor. Later, it became necessary to run longer periods of time each day because of the popularity of the exhibit, so another projectionist and two part-time assistants were added to the staff.

Techniques were developed to allow one person to operate two of the projectors and reproducers. This was possible only if one of the longer films was one of the two films being projected.

The other type of films were the short ones called Vignettes. They were extremely popular, both as to the character of the films and the method of presentation, which was called the Multivox system. Requests for rental or purchase of these films ranged from the entire selection of 90 reels to selected films, and came from many countries throughout the world. Libraries are now set up in Europe, and are planned for Asia and South America. The rigid scientific approach was pleasing to almost every one of our audience.

The number of persons in the audience during the period of the show totaled 15,186; total number of film showings was 1287. The magnitude of this effort may be appreciated by the fact that the small theaters each contained 14 seats and the average film run was about 12 minutes. The number of times that each film was shown varied from a minimum of five to a maximum of 119. The average was about 50. The film that was shown only five times was entered too late to include in the catalog. The film that was shown 119 times was *The Industrial Applications of Nuclear Explosives.*

A Multilingual Audio-Visual System

By HOWARD M. TREMAINE, JAMES W. GREEN and GLENN R. OSBORN

An audio-visual system has been designed with a 16mm rear-projection system, electrically interlocked with a 16mm magnetic film reproducer which carries a four-language soundtrack. A selector switch and headphones at each seat in the auditorium permit the auditor to select the desired language.

As PART OF the United States participation in the Second International Conference for the Peaceful Uses of Atomic Energy at Geneva, four small theaters were constructed for showing 16mm films on the use of atomic energy in scientific and industrial applications. The theaters, built by Lytle Engineering and Mfg. Co., of Culver City, Calif., under a contract with the Atomic Energy Commission, were constructed in a semicircle and utilized a common projection area. Each theater (Fig. 1) contained 14 to 16 seats and a rear-projection system with separate facilities for reproducing the soundtrack from a 16mm magnetic film in the four official languages: English, French, Russian and Spanish. Selector switches at each seat permitted selection of the desired language.

The rear-projection equipment consisted of a metal framework supporting an RCA Model 400 16mm projector at one end and a front surfaced mirror at the other (Fig. 2). The picture, projected onto the surface of the mirror, reflected to a polarized-type screen (manufactured by Polacoat Inc.) to permit viewing in a high ambient light level.

A projector control box mounted at the rear of the projection stand contains an interlock switch for electrically interlocking the reproducer and projector motor systems, a pilot light to indicate when the system is in lock, and a start-and-stop switch. Two coding-decode switches associated with a go-no-go control system prevent the projectionist from inadvertently threading the wrong soundtrack. The go-no-go system may be bypassed, if desired, by a switch on the projection control box.

A decoding device which is part of the go-no-go control system, is mounted between the supply and take-up reels on the reproducer transport systems. The decoding device houses a group of microswitches which control the motor starting circuits. The placement of the decoder with reference to the threading path of the reproducer is shown in Fig. 3.

Figure 4 shows how the go-no-go code is punched in the leader of the magnetic soundtrack. The soundtrack to be coded is threaded through a special punching device containing a group of holes in its upper portion, representing 0 to 9 and 0 to 90. In practice, all holes *except* the desired code numbers are punched in the

Presented on May 6, 1959, at the Society's Convention in Miami Beach by Howard M. Tremaine (who read the paper), Lookout Mountain Air Force Sta., Hollywood; James W. Green, Magnasync Mfg. Co., 5546 Satsuma Ave., North Hollywood; and Glenn R. Osborn, Lookout Mountain Air Force Sta., Hollywood.
(This paper was first received on May 7, 1959, and in final form on October 19, 1959.)

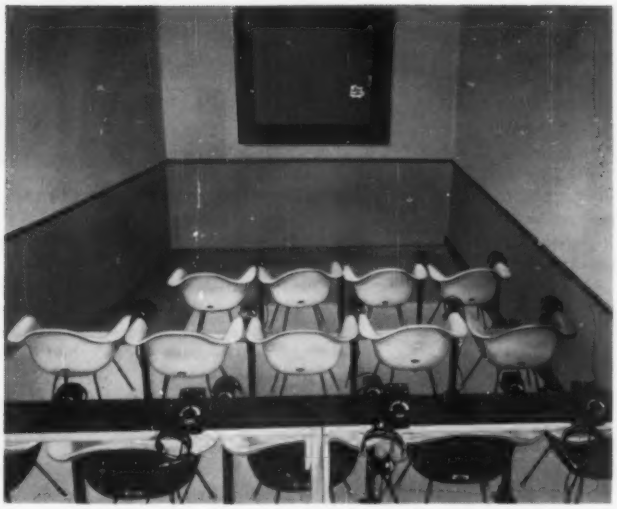


Fig. 1. Interior of theater. Language selector is mounted at each seat. Boxes on rear rail are for the convenience of standees.

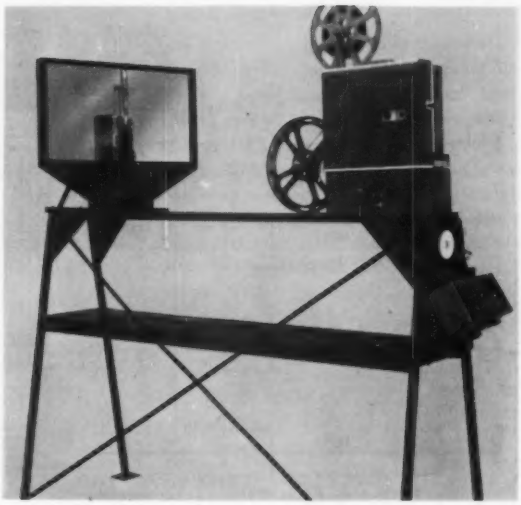


Fig. 2. An RCA Model 400 16mm Projector, with front-surfaced mirror mounted for rear projection.

film including an indexing hole. As an example: if the code number is to be 46, all holes *except* 40 and 6 are punched in the film. The distance between the indexing hole and the soundtrack start sync-mark is 52 frames. Because the magnetic reproducer head is not visible in its shield, a second sync-mark is necessary. This second mark is placed at a distance of 27 frames from the indexing hole in the direction toward the sound start sync-mark. When threading the reproducer this sync-mark is placed at the upper edge of the left film gate at the pulldown sprocket, and is used as a sync-mark, rather than the sound sync-mark. When threaded properly, the sound start sync-mark will lie over the gap in the magnetic reproducer head.

The coding dials on the projector control box govern the operation of the go-no-go system. The dials are set to the code number corresponding to the code number of the selected film. If the motor system is locked in and the code punched in the magnetic soundtrack leader corresponds to the code set up on the dials, the motor system will "roll" when the start button is depressed. If the code punched in the film is wrong, the pilot light on the projector box will not light. This is an immediate indication that the wrong soundtrack has been threaded on the reproducer.

Decoding Device

The decoding device on the reproducer consists of a group of 20 microswitches which are normally open in their upward position. All switches falling under the code number are pressed downward by the pressure of the film on the microswitches and complete the motor control circuits. All other switches in the decoder will remain open because their arms extend through the holes in the film. When the film is pulled downward by the rotation of the pulldown sprocket, a latch at the bottom of the decoder device opens, releasing the film and permitting it to run free of the decoding switches.

The motor system is a conventional single-phase 115-v selsyn interlock, with provision for running the reproducer or projector separately. The lamp in the projector lamphouse is energized automatically when the motor system starts to rotate.

The four-track 16mm magnetic film reproducer consists of a Mark IX transport system and playback amplifier-manufactured by the Magnasync Manufacturing Co. These are mounted in a standard 7-ft cabinet-type relay rack. This rack also houses four power amplifiers which feed the headphone circuits in the theater auditorium. Four VU meters are provided to indicate the levels fed to the headphone circuits. The balance of the equipment consists of a power supply for the playback amplifiers, jack strips, and an automatic monitoring system for the projectionist. Power for both the pro-

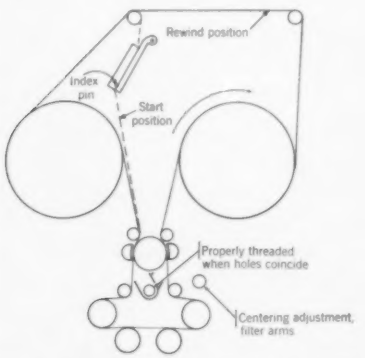


Fig. 3. Threading path of the magnetic reproducer.

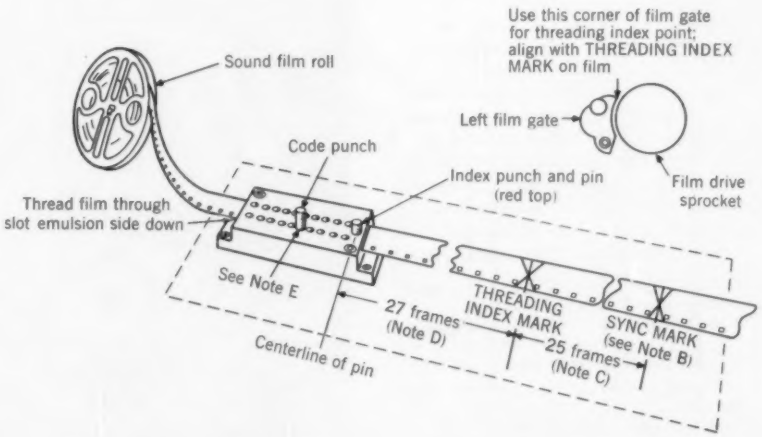

Use this corner of film gate for threading index point; align with THREADING INDEX MARK on film
Sound film roll
Left film gate
Code punch
Index punch and pin (red top)
Film drive sprocket
Thread film through slot emulsion side down
See Note E
27 frames (Note D)
THREADING INDEX MARK
25 frames (Note C)
SYNC MARK (see Note B)
Centerline of pin

Fig. 4. Go-no-go code punched in leader of magnetic soundtrack. Distance between indexing hole and sync mark is 52 frames.

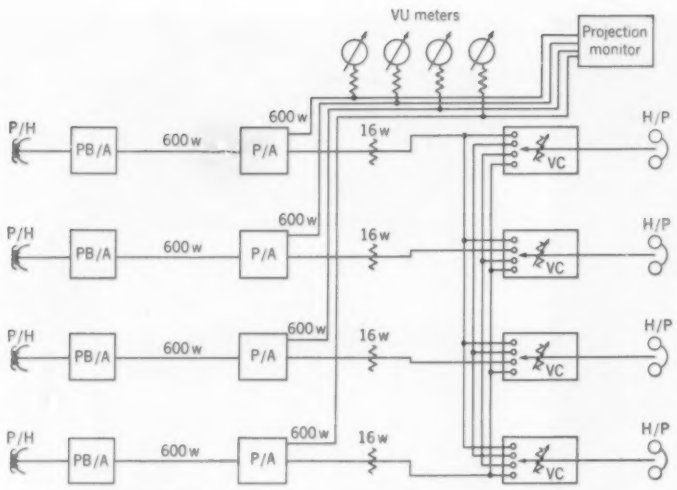


Fig. 5. Block diagram of reproducer system.

jector and reproducing system is brought to a plug panel at the bottom of the rack and then distributed to the projector control box and projector, through cables. Approximately 2500 w is required for each theater.

The projectionists' automatic monitoring system consists of a motor-driven cam switch which alternately connects the projectionists' headphones across each of the four language soundtracks every 15 sec. This provides the projectionist with continuous monitoring of the four soundtracks. The four VU meters at the top of the rack serve to indicate the average level fed to the auditorium headphone circuits. The meters are also used for lining up and setting the headphone levels before the day's work starts.

A block diagram of the audio circuits is shown in Fig. 5. At the left are four input circuits fed from four magnetic heads on the reproducer transport system, terminating in four playback amplifiers. The output from the four playback amplifiers passes through normal jacks, then to four Langevin Model 138SM 8-w power amplifiers which feed the auditorium headphone circuits. The 16-ohm output winding of the power amplifiers is terminated permanently in a 16-ohm resistive load. From the power amplifiers the signal passes through normal jacks and then to the selector switch boxes in the auditorium which contain a high-resistance volume control feeding a pair of Brush Electronics Model 705B dual crystal headphones. The selector switches are of such design that when a headphone circuit is switched from one language circuit to another, the unused lines are terminated in a resistive load equal in value to the headphone circuit impedance.

Since the headphones and the volume control are of high impedance, and are fed from a 16-ohm source impedance, they function as a bridging load across the output circuit of the power amplifiers. Thus, no change in level is reflected between the headphone circuits when the headphones are switched from one language circuit to another.

The cables feeding the auditorium headphone circuits are of special design, consisting of four twisted pairs individually shielded, each shield covered with a cloth braid. The grounds to the shields are carried back to a single point ground connection at the reproducer rack.

Each VU meter is connected across a 600-ohm tap on the output winding of a power amplifier. This same winding is also used to feed the projectionists' automatic monitoring system.

The playback amplifiers are equalized in accordance with the ISO-SMPTE standard for reproducing 16mm magnetic film. The signal-to-noise ratio of the entire system when referred to 2.5% harmonic distortion at 400 cycles is 58 db. The crosstalk level between the four reproducer circuits has an average of 54 db at 1000 cyces when a signal is applied to head number two and the crosstalk level measured at head number one and three.

A four-track magnetic recording head is shown in Fig. 6, and the soundtrack

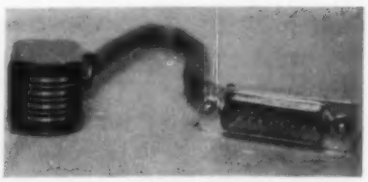


Fig. 6. 16mm four-track recording head.

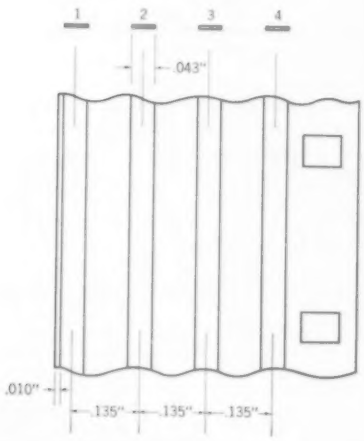


Fig. 7. Soundtrack dimensions.

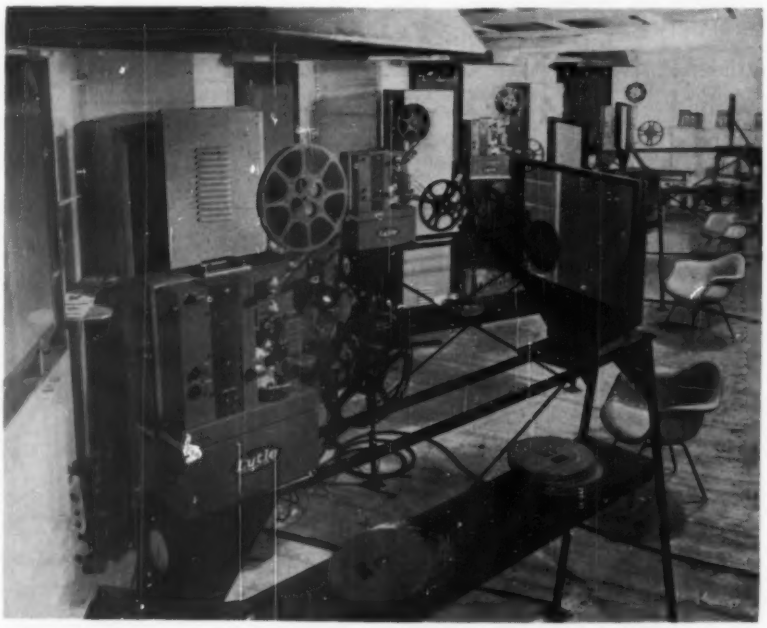


Fig. 8. Rear view of the projection area for the four theaters.

placement dimensions in Fig. 7. Each soundtrack is 43 mils in width, and is placed on a center line between tracks of 135 mils. The recording head impedance is rated 10 ohms at 400 cycles.

The recording amplifiers are designed to permit the four soundtracks to be recorded either singly or in combination. Individual gain controls are provided on the front panel for each recording amplifier, and a variable bias current control on the rear chassis. The VU meter measures both the recording levels and the bias current for each recording amplifier.

A rear view of the projection area for the four theaters is shown in Fig. 8. The exhibit at Geneva ran for the period beginning September 1 and ending September 15, 1958. To assist the delegates in selecting subject matter for screening, a printed program in the four official languages was available. A hostess who spoke several different languages scheduled the subject material selected by the delegates.

Acknowledgments

The authors express their appreciation to Col. J. L. Gaylord, manager of the Lytle Engineering Co., Culver City, Calif.; and Forrest E. Jaquart, engineer, also of Lytle, for his supervision of the operating and installation personnel at Geneva; and to D. J. White, W. H. Stutz and P. F. Schieke of Magnasync Mfg. Co., for their valued suggestions and construction of the recording and reproducing equipment.

Preparation and Transfer of Soundtracks to Four-Track Magnetic Recorder

By GEORGE LEWIN and MAX KOSARIN

Ninety-three reels of narration, each in four languages, were prepared and transferred to a special 4-track (Multivox) magnetic recorder. Problems of synchronization and other technical problems were involved.

FORTY-FOUR DIFFERENT FILMS, comprising 93 individual reels of narration, were prepared by the Army Pictorial Center to fulfill the requirements of the Atoms for Peace Conference at Geneva. Since each reel was to have four languages, the number of individual reels to be transferred to the Multivox recorder was a total of 372.

The original source material, in most cases, consisted of a 16mm composite print in English. From this, translations of the narration were prepared in French, Russian and Spanish. Opening and closing title music tracks were also made and special picture titles were prepared showing the title of each picture simultaneously in all four languages.

A "live" mix was then made of each narration and music. This was recorded on 35mm magnetic-striped film with appropriate start marks. Three 35mm magnetic reproducers and one 16mm optical reproducer were then interlocked for simultaneous transfer of all four languages to the 16mm full-coated magnetic film used by the Multivox recorder.

The problem of synchronizing Army Pictorial Center equipment, which is all 220-v, 3-phase interlock, with the Multivox which is designed for 110-v, single-phase selsyn operation, was solved by replacing the Multivox selsyn motor temporarily with a 3-phase interlock motor to match our system, and by changing the gears to accommodate the 1200-rpm speed of this motor rather than the regular 1800-rpm motor.

The problem of crosstalk between channels proved to be unusually severe because of the fact that the audience must use individual headphones rather than a common loudspeaker. The headphones tend to screen out other extraneous noises such as audience noise which would ordinarily completely mask out any crosstalk. The problem is further aggravated by the fact that the number of words required for technical phraseology is completely different for different languages. The result frequently is that when there is a pause in the narration of a given track the adjacent tracks continue at full level and can be heard because of the crosstalk. This was found to be true even when the measured crosstalk level was fully 43 db below normal signal level. This fact resulted in the recommendation to the equipment manufacturer that the tracks be reduced from 85 mils to half that width so as to more than double the space between them. This did result in a reduction of approximately 6 db in the crosstalk but it is still faintly audible during pauses.* Of course, during actual modulation the crosstalk is completely obliterated and presents no problem.

* The apparent discrepancy between the 49-db (43 + 6) figure which we obtained and the 54-db value which Dr. Tremaine quotes in the accompanying paper can be explained by the different measuring method employed. We feel our measurements are more realistic in that they show the crosstalk existing in an unmodulated track when full modulation is taking place in both adjacent tracks simultaneously.

Interchangeability

One other problem which arose was the matter of interchangeability of recordings made on other similar equipment. For example, the United Nations produced some films which were recorded on a similar multitrack recorder of different manufacture. While the soundtracks were quite satisfactory when played on the same machine on which they were recorded, differences of as much as 10 db appeared when recordings were interchanged. Fortunately, the inherent signal-to-noise ratio of magnetic recording is such that it was only necessary to readjust the playback gain of the various channels in order to obtain completely acceptable reproduction of the interchanged tracks.

Time did not permit us to make a thorough study of all the contributing causes of level differences; but two major causes can be cited: (1) lack of a precise standard for width and location of the individual tracks; and (2) lack of a common standard for establishing the correct recording level.

It is to be hoped that on any future project of this nature, there will be an agreement among the parties concerned — in advance of recording a large number of films — so that satisfactory interchangeability can be achieved.

Presented on May 6, 1959, at the Society's Convention in Miami Beach by George Lewin and Max Kosarin, Army Pictorial Center, 35-11 35th Ave., Long Island City 1, N.Y.
(This paper was received on May 7, 1959.)

87th Convention—Advance Program

Ambassador Hotel, Los Angeles, May 1–6

Since the Convention Postal Announcement was mailed earlier this month Program Chairman Herb Farmer has made no changes in the schedule of sessions. *Instrumentation and High-Speed Photography* will be more strongly represented than indicated earlier. Carlos Elmer of Traid Corp. and Bob Shoberg of Beckman & Whitley have been responsible for high-speed photography papers to relate chiefly to the Space Age topics for which Lloyd Goldsmith is Topic Chairman. *Ben Hur* will be shown for registered Convention members on Friday evening at MGM Studios. This special showing will be followed by a brief question-and-answer period. *The Ladies Program* includes a trip to Disneyland with lunch at the Disneyland Hotel; a glimpse (at least) of the famous Balboa Bay Club; and a visit with Edith Head, Paramount's famous costume designer, and luncheon at the Studio. Wednesday evening is devoted to the cocktail party, banquet and dance. The traditional Coffee Club is sponsored by Hollywood Film Co.

Information on reservations and hotel rates, published in the February *Journal* (p. 122), is included in the Convention Postal Announcement. Members are urged to be prompt in mailing reservations.

If attendance at a session is now being planned for only a specific paper or two, inquire during the week before the Convention by telephoning Program Chairman Herb Farmer (RIchmond 8-2311, Exts. 328, 269, 200).

SUNDAY—MAY 1

10:00–4:00 Registration in the Ambassador Hotel, Los Angeles

MONDAY—MAY 2

9:00 Registration

10:00 GENERAL SESSION

Historical Television Equipment and Materials Collections

SYD CASSYD, *Univ. of Calif., Los Angeles*

Current history recorded by television stations has a slender chance for survival because of the nature of magnetic tape, which can be wiped in a matter of seconds. To prevent this loss, historical television collections are being established in Washington, D.C., Hollywood and New York to preserve films, television-film and magnetic-tape recordings. Cooperation is urged to save this film material, especially the 1930 to 1949 period, and tapes in particular from the beginning.

Subjective Screen Brightness

GERHARD LESSMAN, *Bell & Howell Co., Chicago*

Subjective estimates of screen brightness do not correlate with photometry based upon the CIE, standard photopic luminosity function. Results of some preliminary measurements of subjective screen brightness at various color temperatures are reported. Computations based upon modified luminosity functions postulated for the viewing angle and brightness corresponding to motion-picture projection tend to corroborate these findings. A simple correction factor based on color temperature is suggested for converting measured brightness into subjective screen brightness. An investigation to establish this correction factor is proposed.

An Electrostatic Color Map Printer

DONALD J. PARKER, *Radio Corp. of America, Camden, N. J.*, and F. C. MYERS, *Army Engineer Research and Development Laboratories, Fort Belvoir, Va.*

A feasibility model of an Electrofax Color Map Printer has been constructed and demonstrated under a contract with the U.S. Army Engineering Research and Development Laboratories, Fort Belvoir, Va. This machine is designed to print five color maps $22^1/_2$ by 29-in. by optical exposure from 70mm cartographic separations. The feasibility equipment uses liquid color Electrofax development with electronic flash exposure triggered photoelectrically from the paper. The machine is web fed, the paper transport being accomplished by means of air bearings. The Electrofax approach to tactical map reproduction greatly reduces the requirement for storage of large quantities of printed maps. It reduces the logistics problem to supply of raw materials. The make-ready time is a few minutes.

Synchronous Camera and Sound Drives

LOREN L. RYDER, *Ryder Sound Services, Inc., Hollywood*

The U.S. Army Signal School and Modern Trends of Audio-Visual Education

MICHAEL J. VENEZIA, *U. S. Army Signal School, Fort Monmouth, N.J.*

12:15 Get-Together Luncheon
Guest Speaker: To Be Announced

MONDAY AFTERNOON

2:30 ACOUSTICS AND SOUND

Controlling External Noise for Recording Studios

DONALD P. LOYE, *Consulting Engineer, Los Angeles*

Quite recently, oil wells have been drilled on studio properties, creating new noise and vibration problems. Solutions to these problems include the suitable location of each drilling site relative to studio activities; acoustical insulation of drilling derricks and associated machinery and the mounting of machinery on vibration isolation mountings.

New Sound-Retarding Doors for Motion-Picture Sound Stages

D. J. BLOOMBERG, *Republic Productions, Inc., North Hollywood;* and M. RETTINGER, *Radio Corp. of America, Hollywood*

After discussing the various factors determining the sound-retarding qualities of sound stage doors in general, various such doors, as used at Republic Studios, are described in detail. For the sake of convenience, they are classified as Inside Doors and Outside Doors. The former are double doors using a 1-in. cement plaster coating on each side of the steel frame of the door; the latter are solid concrete doors, 6-in. thick, with an internal steel frame.

Recent Applications of Acoustical Engineering Principles in Studios and Review Rooms

WILLIAM B. SNOW, *Ramo-Wooldridge Corp., Canoga Park, Calif.*

Designing the interior surface of a studio or review room for acoustical control combines science and art in that some problems must be solved scientifically and others require subjective judgments made on the grounds of artistic validity. A specified reverberation characteristic can be obtained with fair accuracy, but other problems must be approached more intuitively. Examples are given of solutions combining engineering and rule-of-thumb approaches.

Transistorized, Portable, Magnetic Film Recording Channel

C. E. HITTLE, M. RETTINGER and KURT SINGER, *Radio Corp. of America, Hollywood*

A portable, magnetic film recording channel has been designed

with a transistorized mixer and recorder, plus some accessories. The mixer provides for switching, equalizing and mixing of up to four microphones. Two independent VU meters indicate recording and magnetic playback levels. Optional accessories consist of microphone impedance matching transformers, headset transformers, precision gain controls and transistorized compressor. A high-gain transistorized playback amplifier and bias oscillator are located in the recorder. The recorder is manufactured by the "matched-plate" method in which the structural support for the primary rotational elements is provided by two match-bored magnesium panels to effect flywheel suspension between two bearings rather than by cantilever fashion.

Audio Scoring, Dubbing and Transfer Techniques Used in Video-Tape Productions

JOHN D. SILVA, *KTLA, Los Angeles*

Many video-tape productions require post-production addition of music and sound effects to the original dialogue. Various methods are employed including the use of an 8-track audio tape machine, incorporating control track, cue track and self-synchronizing features. The equipment allows up to seven audio tracks to be recorded in sync with any or all previous recordings.

An Edit-Dubber System

FRED G. ALBIN, *Ryder Sound Services, Inc., Hollywood*

MONDAY EVENING

7:30 OPTICS and IMAGES

Fiber Optics — A New Tool in Electronics

L. J. KROLAK, *Radio Corp. of America, Camden, N.J.;* R. NEUHAUSER, *Radio Corp. of America, Lancaster, Pa.;* and W. P. SIEGMUND, *American Optical Co., Southbridge, Mass.*

A program in fiber optics has been carried out by RCA for the past 2½ years in cooperation with the American Optical Co. A unique method of stabilizing an airborne TV camera utilizing fiber optics is described. This system uses a vidicon picture tube with a fiber optics face plate and a flexible fiber optics bundle. Also described are a completely nonmechanical high-resolution TV system and a high-speed print-out device, both utilizing fiber optics.

The Design of Zoom Lenses

R. KINGSLAKE, *Eastman Kodak Co., Rochester, N. Y.*

Zoom, or varifocal, lenses have been known since 1930, but they were seldom used until after World War II when they became generally applied to television cameras. During the past ten years several types of zoom lenses for 8 and 16mm motion-picture cameras have been developed. These are either mechanically or optically compensated, and necessarily contain many lens elements. The optical design is difficult, and it is only recently that zoom lenses comparable to ordinary cine lenses have become available.

Films for Machine Use

HARRY BRUEGGEMANN, *Tridea Electronics, Inc., South Pasadena, Calif.*

For the past hundred years, photographic films have been designed to the satisfaction of one judge — the human eye. Recently, however, films have been used for machine read-out, and a new judge must be satisfied — the light-sensitive cell. In nonphysiological applications of film, a fundamentally new engineering approach is required.

A Single-Lens, Peripheral-Field Cinematic Process

RICHARD VETTER, *Univ. of Calif., Los Angeles*

Current research and training requiring driver, flight and gunnery simulation have stimulated efforts to develop practical and effective cinematic means for presenting fields-of-view of up to 180°. A preferred system for simulating peripheral vision should utilize a single lens and film in addition to standard photographic and projection equipment. Thus far, major developmental problems have included poor resolution, image distortion, lack of light in photography, and low illumination in exhibition. The process under discussion satisfies the single-lens, standard equipment requisites and adequately resolves the commonly inherent problems. It is currently in use in certain simulation installations.

The Relationship of Anamorphosis to Object Distance

WALTER WALLIN, *Wallin Optical Systems, Inc., Tarzana, Calif.*

Conventional focusing of a cylindrical anamorphoser is found to result in a variation of anamorphosis as a function of object distance. Since projection takes place at a fixed distance, the proportions of the screen image of an object vary with the distance at which the picture was taken. The nature of this function and possible means of its control are discussed.

The Effect of Composition of Altering Aspect Ratio in Printing

DONALD NICHOLSON, *Technicolor Corp., Hollywood*

When making prints from a negative with a given aspect ratio to positives of different aspect ratio or smaller image size, negative information is lost. This basic concept imposes restrictions on composition when exposing a negative that is to be so printed. The reasons for these restrictions are considered for a number of standard formats and printing methods. Diagrams are given which permit visualization of these composition requirements and limitations.

Motion-Picture Camera Lenses

J. D. HAYES and W. S. FUJIMURA, *Bausch & Lomb Optical Co., Rochester, N.Y.*

Improvement in the quality of motion-picture equipment and materials necessitated by the large-screen presentation of films has required a re-evaluation of the optical characteristics and performance requirements of "professional type" motion-picture camera lenses. Highly corrected lenses, characterized by long back focal length, balanced illumination, flat field performance and high contrast have been developed for use with 35mm and larger format professional-type motion-picture cameras.

TUESDAY MORNING—MAY 3

9:00 FILMS IN INDUSTRY

Film Communications in the Space Age

ROBERT S. SCOTT, *Douglas Aircraft Co., Santa Monica, Calif.*

The problems involved with exploring, interpreting and understanding the Space Age are considered as a challenge to film communications. Examples of solutions include high-speed, infrared and x-ray photography; remote control devices; missile-mounted cameras; the Earth as seen from distant missiles; and some new developments in animation.

Planning and Production of Industrial Films for the Bell System

H. L. VANDERFORD, *American Telephone and Telegraph Co., New York*

The production of public relations and training films for the Bell Telephone System requires a staff thoroughly familiar with the telephone business as well as motion-picture techniques. About 17 films are produced annually by the A.T.&T.'s film staff. One of the functions of the staff is to program production of films and associated materials of common interest to the majority of the 21 associated telephone companies where uniformity is desirable and economies can be realized through centralized production. An annual film program may include various types of employee training films as well as films for public exhibition in the form of science shorts, musicals, animated cartoons and screen plays.

An Industrial Audio-Visual Department

JAMES A. BOSTWICK, *Audio Visual Dept., General Motors Photographic, Detroit*

Extensive facilities and personnel are organized to produce 2 by 2 slides for illustrations and motion pictures. The types of films produced are described and samples shown.

The X-15, the Case History of a Film

WILLIAM M. BROSE, *North American Aviation, Inc., Los Angeles*

The history of the production of a documentary film on the X-15 is told from the film writer's viewpoint. Recording the chronological progress of this space research vehicle resulted in a 26½-min. program for public release. Evolution of the film from a series of engineering progress reports into a comprehensive review of the developmental period is discussed in detail.

TUESDAY AFTERNOON

1:15 INSTRUMENTATION IN THE SPACE AGE

Application of 35mm Sprocket Hole Film to Instrumentation Recording

G. R. CRANE and J. W. STAFFORD, *Westrex Corp., Hollywood*

Perforated-type film has certain inherent advantages as a recording medium. Performance characteristics of flutter, drift, skew and general operational stability of a typical transport system using 35mm perforated film are given. Standard 5-mil cellulose acetate, as well as 3-mil and $1^1/_2$-mil Mylar base films are included at speeds from 9 to 126 in./sec. Analysis of performance serves to indicate advantages to be gained in applying sprocket-hole film to instrumentation recording.

A New Look at High-Frequency Magnetic Recording

CHARLES E. ANDERSON, *Ampex Corp., Redwood City, Calif.*

Hundreds of magnetic recorders are in use throughout the world as storage devices for television images; but there are relatively few instances of full use of the recorder's capabilities in other fields. The possibility of using the magnetic recorder in new fields is explored. Improvements developed for nontelevision recording are examined for usefulness in television recording.

Ultra-High-Speed Streak Camera Utilizing Mirror Optics

JACK PATTERSON, *Beckman and Whitley, Inc., San Carlos, Calif.*

Parameters for conventional sweeping-image camera design are easily exceeded through the use of a new mirror optical-relay system. This optical configuration allows all components to be arranged in a simple "on axis" design. The incorporation of mirror optics into streak camera design opens new areas of observation and new fields of application.

Radio-Controlled Remote Starting and Automatic Synchronizing Device for Cameras and Recorders

ARTHUR FLORMAN, MICHAEL SHRAYER and DOMINICK NOTTO, *Florman & Babb, Inc., New York*

A device for starting and synchronizing the Mitchell NC and the Magnasync Mark IX recorder has been designed to be especially useful in situations where the setting or subject precludes the use of slates and clapsticks. It is activated by a remotely positioned radio control and only one switch is required to initiate the operation. The device may also be activated by means of a pocket-sized radio control.

A Transistorized Vidicon Camera for Industrial Use

M. H. DIEHL and RICHARD J. CLARK, *Studio & Industrial TV Eng., General Electric Co., Syracuse, N.Y.*

A compact, single-unit camera has been designed to be capable of high-quality television picture. Problems encountered in transistorizing video, sync, sweep and power supply circuits are discussed. There are four integrated optical accessories: remote focus, remote iris, remote turret and douser. Performance characteristics of the camera under conditions of shock and vibration, temperature extremes and high acoustical noise level are given.

Cinetheodolite Measurements of Earth Satellite Orbits

D. F. KEYES and D. L. TIEMANN, *Naval Ordnance Test Station, China Lake, Calif.*

Askania and Naval Weapons Plant cinetheodolites at the U.S. Naval Ordnance Test Station, China Lake, Calif., are providing accurate measurements of artificial earth satellite orbits in a flexible, low-cost program. A natural outgrowth of many years of experience using cinetheodolites to determine missile trajectories, the satellite observation program is extending the capabilities and usefulness of these precision instruments.

TUESDAY EVENING

8:00 Address by Krafft A. Ehricke, Director, Vega and Centaur upper-stage rocket programs, Convair (Astronautics) Division, General Dynamics Corp.

8:30 SPACE TECHNOLOGY

Eyes for the Astronaut

H. G. SENNERT and C. D. MAURER, *Missile & Space Div., Lockheed Aircraft Corp., Sunnyvale, Calif.*

In the vast reaches of space unaided human eyesight is incapable of performing the myriad of required functions. There are numerous applications in which motion-picture and TV equipment become a powerful aid to the astronaut. Such applications impose new rigorous requirements on equipment design and performance and highlight a whole series of technical problem areas. The urgency of Space Age problems has served as a catalyst to trigger industry creative ability. Space applicat ons of motion-picture and TV equipment are a current reality.

Direct-View Monitor for a Photo-Transmission System Employing Storage Tubes

WILLIAM ARM, *Fairchild Camera and Instrument Corp., Syosset, N.Y.*

The function of the Direct-View Monitor is to give an instantaneous visual presentation of successive video frames as they are being transmitted from some remote position. Each frame is visually retained, without noticeable deterioration, for at least 16 sec which is about twice the transmission time of one frame. If desired, any frame can be retained for a longer period. Two RCA 7315 storage tubes are employed as display units. Each tube alternately displays every other frame. Thus, while one tube is writing a frame, the other is displaying the preceding one. Any completed frame can be retained for a longer period of time on one tube, while the subsequent frames are successively displayed on the other. The logic circuits involved in switching the storage tubes and the general operation of the storage tubes and their associated circuitry are discussed.

A Narrow-Bandwidth Video-Tape Recorder for Use in a Satellite

JOSEPH A. ZENEL, *Radio Corp. of America, Princeton, N.J.*

A magnetic tape recorder intended for use as a video recorder, that is, a storage device for television-originated images, has been developed. How the extremely smooth tape motion is obtained within the limited volume and weight permitted a recorder intended for a satellite is described. The novel design which has been developed also satisfies the requirement of very low power consumption. Electrical performance and physical characteristics are presented in detail.

WEDNESDAY MORNING—MAY 4

9:00 EQUIPMENT PAPERS and DEMONSTRATIONS

(See the Directory of Equipment Exhibits on subsequent pages.)

WEDNESDAY AFTERNOON

1:15 PHOTOGRAPHIC MATERIALS AND EQUIPMENT

A High-Speed Black-and-White Negative Film

F. W. SPANGLER and H. R. BEILFUSS, *Film Emulsion Div., Eastman Kodak Co., Rochester, N.Y.*

The new camera film, Eastman Double-X Panchromatic Negative Film, Types 5222 (35mm) and 7222 (16mm), has been designed to give more than twice the speed of Eastman Plus-X Panchromatic Negative Film (Type B), Types 4231 (35mm) and 7231 (16mm), without any significant increase in graininess. This permits exposures under adverse lighting conditions, or with increased depth of field without an increase in illumination, or with greater economy in set lighting. The new film will find wide application for general motion-picture work and television use. Processing and printing procedures are compatible with those used for Types 4231 and 7231. The characteristics of the film which affect picture quality are discussed.

Two High-Speed Color Films and a Reversal Print Film for Motion-Picture Use

N. H. GROET, T. J. MURRAY and C. E. OSBORNE, *Research Laboratories, Eastman Kodak Co., Rochester, N.Y.*

Eastman (or Kodak) Ektachrome ER Daylight and Type B films are high-speed color reversal camera films designed for 35mm and 16mm motion-picture photography. Ektachrome Reversal Print Film, designed for the same process as the camera films, may be used for making high-quality duplicates of the camera originals. Film structure, sensitometric characteristics, exposure requirements, suggested filters and printing behavior of the new films are discussed.

A Solvent Cleaning Machine for Motion-Picture Film

R. V. POWER and H. L. BAUMBACH, *Computer Measurements Co., Sylmar, Calif.*

A machine has been developed to clean motion-picture film automatically at speeds up to 300 feet/min while it is submerged in a solvent bath. Special design aspects of the machine include rotating velvet covered rollers which clean the film as it passes over them in the solvent bath; a solvent recovery system; film drying, and the selection and use of special solvent resistant materials.

A Cartridge Loaded, Variable Speed, 16mm Motion-Picture Projector

LEONHARD KATZ, *Woburn Engineering Co., Woburn, Mass.*; and NORMAN C. DAHL, *Massachusetts Inst. of Technology, Cambridge, Mass.*

A motion-picture projector was designed especially for use in classrooms as a teaching aid. Requirements included ease of loading, high light levels, high-quality sound and general "school-proofing". A model was constructed with endless loop cartridges which require no rewinding; high-fidelity stereophonic sound; very low noise level of the projector; variable frame rate of the film from 0 to 16 frames/sec with constant flicker rate over the entire range; automatic start and stop; automatic loop formers without sprockets for the film; electronic speed control and synchronization.

A New Sound 8 Projector

ROBERT J. ROMAN, JOHN M. MORIARTY and ROBERT B. JOHNSON, *Apparatus & Optical Div., Eastman Kodak Co., Rochester, N.Y.*

A new Sound 8 Motion Picture Projector is described. Color slides are used to illustrate a detailed product analysis covering basic construction, the projector drive, sound drive and electronic system. Major aspects of projector performance are presented together with some comments on the use and future of this development.

Engineering Aspects of 8mm and 16mm Magnetic Film Striping for High-Quality Audio or Data Recording

WALTER BACH, *Bach Auricon Co., Hollywood*

Magnetic record and playback contact and wear characteristics affect various types of pre-striped 8mm and 16mm motion-picture film. These characteristics are analyzed and illustrated.

Double-System Sound for 8mm

WILLIAM B. STANCIL, *Stancil-Hoffman Corp., Hollywood*

A practical, inexpensive, highly portable 8mm motion-picture recording system is described. A standard amateur camera and a standard dual-track, self-contained portable recorder are connected electrically to provide lip-synchronization during recording. Reproduction may be either double system or a magnetic-striped print made by transfer.

WEDNESDAY EVENING

6:45 COCKTAIL PARTY, BANQUET, DANCE

THURSDAY MORNING—MAY 5

9:00 LABORATORY PRACTICE

A Survey of Footage and Scene Counters Used in the Motion-Picture Industry

CARL W. HAUGE and SIDNEY P. SOLOW, *Consolidated Film Industries, Hollywood*

A number of counting systems and various types of read-out units have been developed in the last few years. Comparison of the counting techniques are made and advantages and disadvantages summarized.

The Use of a Strobe Lamp as a Stable Light Source in a Cinex Tester

EDWARD H. REICHARD and LEONARD L. SOKOLOW, *Consolidated Film Industries, Hollywood*

By using a strobe lamp with its capacitor discharge power supply, a simple, highly reproducible light source is built into a Cinex Tester. This light source eliminates voltage and/or ammeter settings and a mechanical shutter, all of which can contribute errors. The exposure is 1/100-sec duration, which automatically eliminates the effects of reciprocity failure and therefore produces an image in which the tone reproduction exactly matches that of the printing machine.

Optical Printing of Liquid-Coated Negatives at Technicolor

HENRY O. IMUS and JOSEPH W. SCHMIT, *Technicolor Corp., Hollywood*

Surface grain and abrasion defects emphasized in optical printing from single-strip color negative for wide-screen presentation were formerly minimized by means of lacquer coatings and diffuse printer optics. This method resulted in lacquer dirt and loss of definition. Technicolor matrices of greatly improved quality are now printed from "wet" negatives, i.e., the negatives are run through a perchlorethylene bath, doctored by means of air and/or vacuum squeegees, printed, then dried with air jets before being taken up.

Automatic Developer Solution Replenisher Control by Infrared Cuing

ROBERT M. GRUBEL and CARL W. HAUGE, *Consolidated Film Industries, Hollywood*

By using an infrared light source and a phototube sensitive in this region, it is possible to monitor the film entering the developing section of a continuous processing machine and to control the replenisher rate to match load conditions. The developing solution used with this system is discussed with reference to stability.

Film Processing and After-Treatment of 16mm Films

L. J. WHEELER, *British Broadcasting Corp., London*

A daylight-operated continuous film processing equipment is used in the BBC TV newsfilm service. It uses a sprocket drive and is capable of processing 16mm film at a speed of 60 ft/min. The paper also describes equipment for applying a protective coating to the film after processing, and gives the results of tests on the degree of protection achieved.

Control Techniques in Film Processing

E. H. REICHARD, *Consolidated Film Industries, Hollywood*

For more than two years the Society has been engaged in the preparation of an authoritative text and reference book on laboratory control procedures. A review of the book includes a description of the contents and brings out the importance of this publication to the industry.

Exposure Control in Television Film Recording

RODGER J. ROSS, *Canadian Broadcasting Corp., Toronto*

Attempts to "improve" the picture quality of film recordings by adjustments of recorder setup or modifications of the film process have, for the most part, produced disappointing results. The advantages of a constant density and density difference film process are outlined. Sensitometric analysis of film response characteristics and exposure conditions may be employed for accurate control of image formation. A linear overall transfer characteristic may be achieved by selecting the most favorable operating conditions. To maintain these conditions a sensitive and accurate recorder photometer is required, together with a standard reference staircase signal. A photometer has been designed, using a modified Densichron amplifier and probe, and a calibrating light source.

Cathode-Ray Tube and Photographic Film Characteristics Related to Film Recording for Television

MEIER SADOWSKY, *Continental Electronics Corp. of Calif., Los Angeles*

Today's needs in TV film recording are related to the cathode-ray tube parameters of phosphors, screens, aluminizing spot size and operating characteristics. The spectral emission and decay characteristics of phosphors pertinent to photography are described; the effects of the physical characteristics of the phosphor and screen are evaluated in relation to problems of uniformity and impurities. Methods of exposure and the response characteristics of commercially available film are evaluated. The relation of phosphor screen characteristics to film in the optical system is shown.

Shutter Cycles for Television Film Recording

F. N. GILLETTE and B. D. PLAKUN, *GPL Div., General Precision, Inc., Pleasantville, N.Y.*

The camera used in transferring television program material from the picture tube to motion-picture film requires special shutter treatment. Since the TV image is formed in successive downward sweeps, shutter opening must be timed to span one complete sweep cycle; otherwise, the film shows an overlap or underlap strip known as "shutter bar." This and other factors affecting shutter bar are described by reviewing fundamental relations between the film exposure cycle and the television scan. Practical arrangements for eliminating shutter bar are described and analyzed. Effects of phosphor persistence and reciprocity law failure are considered.

THURSDAY AFTERNOON

1:30 TELEVISION RECORDING

An Analysis of the Problem of Splicing Video Tape

MELVIN W. SMITH, *S & S Mfg. Co., Alta Loma, Calif.*

Physical joining of television magnetic tape requires extremely close mechanical tolerances. This paper discusses design considerations of the splicing machine and techniques which make tape splicing a fast, simple procedure even for a relatively untrained operator.

An Improved Device for Splicing Video Tape

HAROLD HUMMEL and FRED PFOST, *Ampex Corp., Redwood City, Calif.*

After consideration of the basic requirements for a television-tape splicer, a novel method has been designed for locating field pulses without the use of "tape developer" by employing specially designed flux sensitive heads. The new unit is self-contained and includes precision tungsten carbide cutting bars.

Multiple Standard Switching System for Video-Tape Recording

KURT MACHEIN, *Ampex International, Redwood City, Calif.*

The operational use of multiple-standard recorders by broadcasters who wish to make taped programs which can be broadcast in countries which do not use the 525-line 60-field system is described. Application to specialized nonstandard scanning systems, such as proposed for Stratovision, or high-fidelity 1000-line recording is suggested.

Intersynchronization of Television Magnetic Tape Recorders: A New Tool for the Television Broadcaster

HAROLD V. CLARK, *Ampex Corp., Redwood City, Calif.*

Synchronizing the playback of a television magnetic tape recorder with other video signal sources in the station imposes stringent requirements on the control of the rotating video scanning head, since 0.1-μsec timing error will result from only 0.00864 degree of error in instantaneous angular position of the head. Some possible methods of control are reviewed and the development of a practical system is described.

Intersynchronization of Television Magnetic Tape Recorders: A Circuit Analysis

DONALD B. MACLEOD, *Ampex Corp., Redwood City, Calif.*

An account is given of the circuit design and techniques used in the drum control servo. The circuits described, many of which have been transistorized, include the means for the vertical and horizontal sync pulse phase comparison and the utilization of these signals in a linear phase modulation system to control the drum motor to a high order of precision. Several auxiliary circuits such as the 30-cycle edit pulse derivation are also mentioned.

The Measurement of FM Deviation in TV Tape Recording

A. H. LIND and A. C. LUTHER, *Radio Corp. of America, Camden, N.J.*

The recording of the video modulated carrier on the tape in TV tape recording must be done with care if the maximum potential of the system is to be realized on a basis that permits universal interchangeability of tapes in playback. A discussion of the basic limiting parameters in the system is followed by a description of several methods of measurement, including a new technique that offers greater operational convenience than previously available.

Effects of Pre-emphasis and De-emphasis in Videotape* Recording

SIDNEY S. DAMRON, *Ampex Corp., Redwood City, Calif.*

Pre-emphasis, de-emphasis, carrier frequency, and deviation are among significant parameters affecting tape interchangeability in monochrome and color Videotape* recording. In addition, these factors are important because of their relationships to signal-to-noise ratio and bandwidth. The design philosophy of the color-monochrome, modulator-demodulator for the VR-1000B Videotape* recorder was heavily influenced by these considerations. The practical problems posed and their solutions are discussed along with the improvements achieved. (*Trademark, Ampex Corp.)

A Progress Report on Video-Tape Standardization

CHARLES E. ANDERSON, *Chairman, SMPTE Video-Tape Recording Committee.*

The SMPTE Video-Tape Recording Committee was constituted July 11, 1958. The first report was presented by A. H. Lind before the Society's 1959 Spr ng Convention in Miami Beach. This report covers the current status of the work of the Committee and outlines progress made during the year.

THURSDAY EVENING

7:30 TELEVISION RECORDING

Thermoplastic Recording

W. E. GLENN, *General Electric Research Laboratory, Schenectady, N.Y.*

A method is described for recording electrical signals. Information

is written by means of a very fine electron beam on a film consisting of a low-melting thermoplastic material. This can be projected as a black-and-white or full color image or can be converted to an electrical signal. The film is processed by quick heating and can be erased and reused. The process and the recording equipment are described and a thermoplastic record of off-the-air television is demonstrated.

The New Video-Tape Recorder, Toshiba System

NORIKAZU SAWAZAKI, MOTOI YAGI, MASAHIRO IWASAKI, GENYA INADA and TAKUMA TAMAOKI, *Matsudo Research Lab., Tokyo Shibaura Electric Co., Kawasaki, Japan*

The new video-tape recording system, Toshiba VTR, uses only one revolving head, and is capable of continuous recording of the whole TV field on a slant track on the magnetic tape. Problems previously encountered with multiple head systems are avoided, and simplification in both construction and operation results from this innovation. This system is expected to be particularly effective when used for color video recording.

Operational Features of the VR-1000B

JOSEPH ROIZEN, *Ampex Professional Products Co., Redwood City, Calif.*

A Video-Head Assembly for Recording Primary Standard TV Tapes

A. H. LIND and H. G. WRIGHT, *Radio Corp. of America, Camden, N.J.*

A need exists for standard reference recorded tape for alignment of TV tape recorders. Techniques for making such tapes include the use of a precision standard video-head assembly to record primary standard tapes.

Teleproduction With Video Tape

ROBERT DAY, *Ampex Professional Products Co., Redwood City, Calif.*

Video Tape in Education

HOWARD TOWN, *National Education Television and Radio Center, Ann Arbor, Mich.*

FRIDAY MORNING—MAY 6

9:00 TRAINING PERSONNEL FOR TELEVISION AND MOTION PICTURES

A Brief History of Professional Education in Cinema

ROBERT W. WAGNER, *Ohio State University, Columbus, Ohio*

The history of the motion picture is the story of trial and error, of improvisation, of imitation and intuition. The apprenticeship system was, and largely remains, the usual method of learning motion-picture techniques. In the late 1920s and early 1930s a few universities began offering organized courses in film technique. Today, many educators and leaders in the motion-picture industry agree that the medium deserves serious and critical study, and that there is a critical need for a larger pool of talented young people who must be specifically trained if we are to maintain our historic leadership in the motion-picture arts and sciences.

Film and Television Education: A Marriage of Convenience or Necessity?

RICHARD J. GOGGIN, *New York University, New York*

We can arrive at criteria for future successful curricula initially through a knowledge of the past practices in motion-picture and radio education, and more particularly through an examination of the present interindustry relationships. These relationships have more than the obvious relevancy for teachers; they provide academically sound and professionally necessary guideposts leading to the goal of developing creative and well-rounded students who have been trained within the context of internally-integrated curricula in motion-pictures and television.

Training for Film AND Television

RUDY BRETZ, *Univ. of Calif., Los Angeles*

In the all too short time available for training a student we can give him either a thorough vocational training in a limited field or a more cursory familiarization over a broader area. For some students the first is desirable. For the university student, however, the broader view is preferable. In training *production* personnel for television and motion pictures we are unrealistic if we allow a student to limit himself to the study of just one medium.

Training of Motion-Picture and TV Personnel in Europe and the Middle East

DON G. WILLIAMS, *Univ. of Kansas City, Kansas City, Mo.*

Training available today for motion-picture and television personnel in France, Italy, Spain, Germany, Great Britain, Russia and other European and Middle Eastern Countries varies in greater or less degree from country to country. A comparison of training methods and available facilities suggests a relationship between technical progress, and quality and availability of training. Training methods are evaluated in terms of national and international requirements.

An Analysis of Motion-Picture Production Courses at Ten Universities

JOHN H. TYO, *System Development Corp., Santa Monica, Calif.*

A depth survey was made of motion-picture film production courses in the ten U.S. universities which have been identified as offering the largest number of such courses. Eleven subject-areas including cinematography, editing, directing, recording, writing, etc., are analyzed, first for each school, and then for all ten schools, from the point of view of amount, content, methods of teaching, and evaluation techniques. Administrative practices for film production courses are compared.

Training Army Personnel for Motion Pictures and Television

MAJ. DOUGLAS W. GALLEZ, *Army Pictorial Center, Long Island City, N.Y.*

The Army has continuing need for personnel trained in motion-picture and television production, for sociopsychological researchers to evaluate production techniques, and for skilled technicians to operate and maintain equipment. Visual media are being exploited for education and training, and for morale purposes. Increased emphasis upon research and development has occasioned greater demand for personnel experienced in photographic instrumentation and engineering. The training program existing today and anticipated future needs are discussed.

Television Viewing in Classrooms

JOHN W. WENTWORTH, *Broadcast & TV Div., Radio Corp. of America, Camden, N.J.;* G. J. WHITLEY and H. K. SHOAF, *RCA Victor Div., Radio Corp. of America, Camden, N. J.*

The viewing of television programs in classrooms involves problems slightly different from those encountered in normal home TV viewing. Some of the major problems analyzed are ambient illumination, glare, viewing angles and ratios, and audio power requirements. A receiver designed specifically for classroom viewing is described.

A Closed-Circuit Television System for Centralized Audio-Visual Projection

RUDY BRETZ, *Univ. of Calif., Los Angeles*

A method is proposed for installing of closed-circuit TV as a means of transmitting instructional motion pictures, films, magnetic tapes, slides and live television to television receivers in classrooms and auditoriums throughout the University Campus. A central projection room will be established containing three film chains and projectors. Additional chains and projectors will be added as needed. Facilities will be provided for a maximum of eighteen simultaneous transmissions.

Transmission Facilities for the Anaheim Educational Television Project

MAX P. BEERE, *Pacific Telephone and Telegraph Co., San Diego, Calif.*

The Anaheim Elementary School System's educational television

network interconnects 17 schools with its studio. The schools are located within an area of about 20 miles and are linked together by some 22 miles of coaxial cable, suitably amplified. The network is designed for six adjacent channels utilizing the five standard low-band channels plus one channel in the FM band.

FRIDAY AFTERNOON

1:30 TELEVISION EQUIPMENT AND PRACTICES

The Problem of the Unrestored Television Receiver

ROBERT J. NISSEN, *KQED, San Francisco*

It is maintained that correct gray-scale reproduction is the most important parameter of television picture fidelity. The absence of d-c restoration in the modern home receiver, under certain picture conditions, will almost totally destroy proper gray-scale reproduction. Results are reported from a survey of set manufacturers which questioned their reasons for excluding this critical circuitry. To alleviate the unrestored picture problem, until restoration circuits are again included in the home receiver, operating procedures and standards based on the use of the transmission waveform as a guide are proposed to the broadcast engineer.

An Analysis of Noise in the Image Orthicon

B. H. VINE, *Electron Tube Div., Radio Corp. of America, Lancaster, Pa.*

The problem of how to design a camera tube to operate at light flux levels lower than those presently used without reduction of the signal-to-noise ratio is examined. It is shown that any increase in photocathode sensitivity or mesh transmission allows a corresponding reduction in the light required for equal performance. On the other hand, increases in the secondary-emission ratios of the target of first dynode, even if indefinitely large, can only produce a limited reduction in the light required for equal performance.

New Concepts in TV Cameras

S. L. BENDELL and H. N. KOZANOWSKI, *Radio Corp. of America, Industrial Electronics Products, Camden, N. J.*

Television cameras, electrically stabilized to produce optimum picture quality with a minimum of operator attention, have been developed. Such cameras have long-term precision recycling characteristics and are interchangeable without readjustment. Reliability is obtained by the use of premium tubes, nuvistors, and conservative design. These attributes have been incorporated in a new 4½-in. image-orthicon camera.

Operation of a New Image-Orthicon Camera

CYRIL TEED, *Marconi Wireless Telegraph Co., Ltd., Chelmsford, Essex, England*

Operation features of the new 4½-in. image-orthicon Marconi Camera are discussed with emphasis on broadcasting problems and requirements. A new design idea has been incorporated to achieve stability and versatility and to simplify the operation of the camera.

A Versatile Distribution System for Telecine and Video-Tape Signals

GLEN AKINS, *American Broadcasting Co., Hollywood*

An auxiliary video switcher employing a compact, low-capacitance rotary switch permits a typical television switching system to handle an additional forty input signals. Sync mixing and audio switching functions are automatic. An interlock facility is provided for joint operation of two or more switching systems.

A Mobile Color Video Tape Recording Unit

WILLIAM BARNHART, *Ampex Professional Products Co., Redwood City, Calif.*

FRIDAY EVENING

7:45 BEN HUR, MGM STUDIOS (THEATER)

Exhibit Directory

Ampex Corporation Booths **212, 214, 216**
Redwood City, Calif.

Exhibiting: Two new Ampex Videotape Recorders; Marconi Mark IV Television Camera Chain, and accessories.

Personnel: Jack Miller, Joe Silver, Hal Hummel, Bob Day, Jack Neitlich, Joe Roizen, Cyril Teed, Bill Barnhardt, Eldon Brown, Charles Swisher, Ed Aleks, Tom Merson, Frank Gonzalez, Bill Wallace, Jack Hauser.

Arriflex Corporation of America Booths **208, 210**
257 Park Ave. South, New York 10
7303 Melrose Ave., Los Angeles 46

Exhibiting: The Arricord—a single-unit double-system synchronous sound recording outfit comprising an Arriflex 35 and a 17½mm magnetic film recorder in a single blimp; Arriflex 16 with signal generator and Maihak ¼-in. tape recorder; Schneider lenses in new series of Cinegons and Cine Xenons; Taylor Hobson Cooke lenses in Kinetal series and Speed Panchro Series II; nickel cadmium batteries with built-in Mini-charger.

Personnel: Paul Klingenstein, Victor James, Michael Zois, Abbott Sydney, Richard Halpert, Carl Nuernberg.

Bach Auricon, Inc. Booth **115**
6946 Romaine St., Hollywood 38

Exhibiting: Auricon and Datasync 16mm Sound-on-Film and Data Recording Cameras, including Auricon Cine-Voice II, Auricon Pro-600, Auricon Super 1200, Filmagnetic Recording Systems, Datasync "Photo-tape" Electronic-Optical Data Recording Equipment, Multiple-track Datasync Filmagnetic Projection Equipment, Auricon "VFR," Video Film Recording Equipment.

Personnel: Walter Bach, William G. Straube.

Bell & Howell Co. Booth **102**
7100 McCormick Rd., Chicago 45, Ill.

Exhibiting: The Bell & Howell Model JM 16mm Motion-Picture Printer, and accessories.

Personnel: James L. Wassell, Malcolm G. Townsley.

Birns & Sawyer Cine Equipment, Inc. Booth **201**
6424 Santa Monica Blvd., Hollywood 38

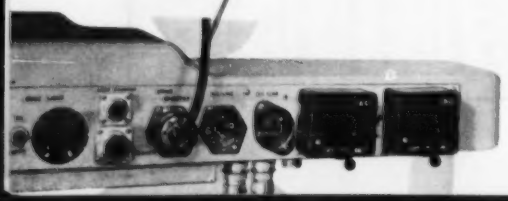
Exhibiting: Omniscope Tracking Finders; Omniscope Lenses (telephoto system); Omnipod Lens Cradles; Birns & Sawyer Heater Barneys; new tripods for Arri cameras; sports and tracking finder for Arri cameras.

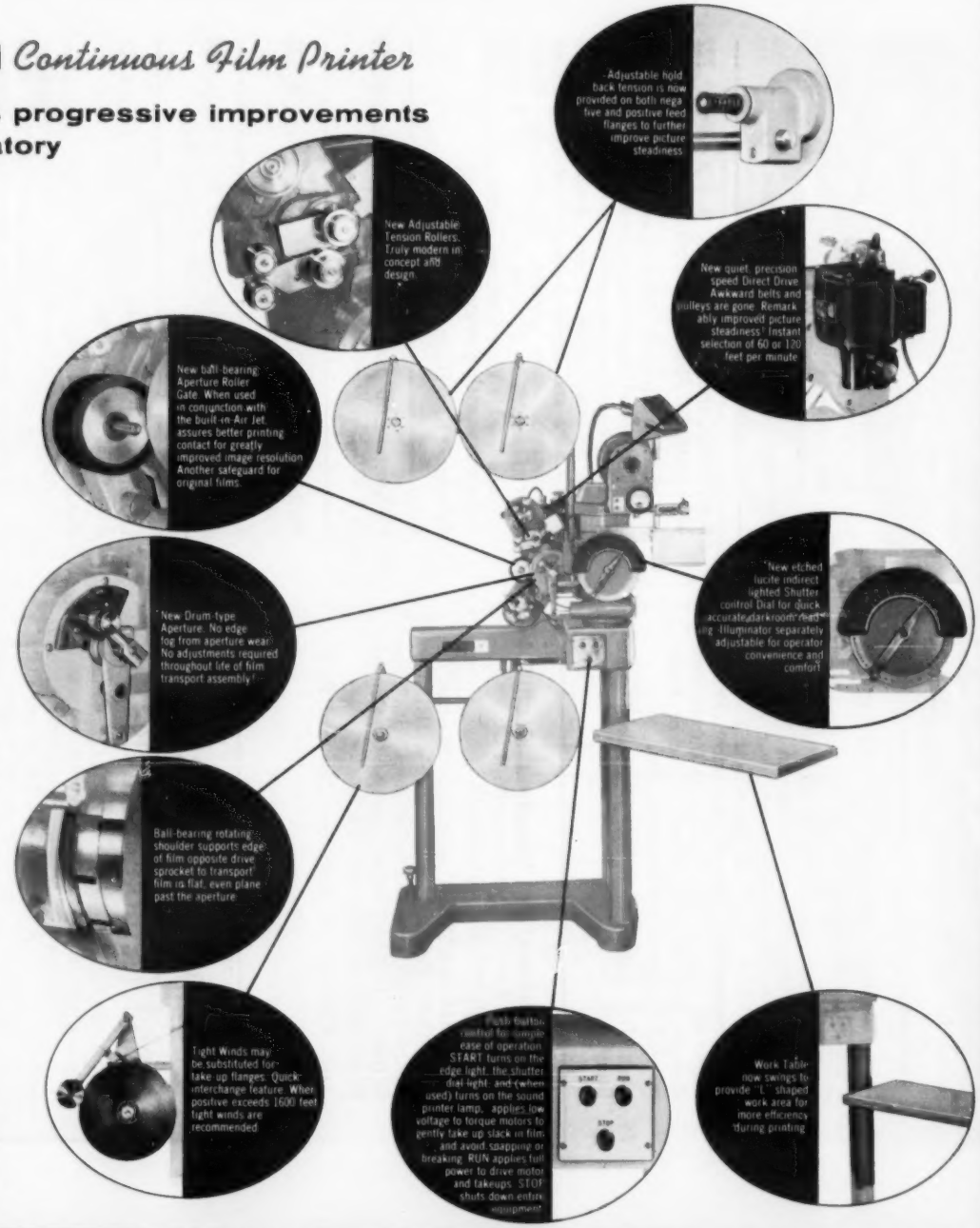
Personnel: Jack Birns, Cliff Sawyer, Pat Watson.

Bell & Howell *Continuous Film Printer*

The "JM" brings progressive improvements to the film laboratory

- The 100% ball-bearing film transport system will extend the quality printing life of any film. With the "velvet treatment" of this transport, film literally flows through the entire printer on ball bearings.
- Amazingly improved picture steadiness!
- Much higher image resolution.
- New built-in Edge Light feature allows key footage numbers to be printed in absolute synchronism right at the aperture!
- New Aperture Printing Sprocket design with *smooth* ball-bearing action.
- New feather-weight Back Shutter of magnesium.
- New ball-bearing Rotating Shoulder opposite main drive sprocket. The "JM" now evenly supports BOTH edges of the film at the aperture during printing.
- New built-in Air Jet behind the aperture for increased steadiness.
- New improved design of Feed and Takeup Flanges—2000 foot capacity.
- Highest quality precision prints from the "JM" printer will help you maintain customer satisfaction and insure your profits on every printing job.
- Compact electrical distribution panel under shelf of new Triplex base. Seven cable receptacles and all circuitry provided in unit panel for AC and DC input, power for drive motor, AC for sound head, current for 3 torque takeup motors and two interlocked AC and DC quick re-set circuit breakers to protect the entire electrical system. Two additional cable receptacles afford connections to an accessory tape reader (when operating with automatic shutter control) and also for loop-tree printing equipment. An on-off switch with a separate rheostat is provided for variable control of the key footage printing lamp. An adjustable control for dial light intensity and a 2-position switch for MANUAL-AUTOMATIC printer operation complete the panel arrangement. All switches, connectors, and circuit breakers have been selected for 200% to 400% excess capacity to assure trouble free performance.




Adjustable hold-back tension is now provided on both negative and positive feed flanges to further improve picture steadiness
New Adjustable Tension Rollers. Truly modern in concept and design.
New quiet, precision speed Direct Drive. Awkward belts and pulleys are gone. Remarkably improved picture steadiness! Instant selection of 60 or 120 feet per minute.
New ball-bearing Aperture Roller Gate. When used in conjunction with the built-in Air Jet, assures better printing contact for greatly improved image resolution. Another safeguard for original films.
New etched lucite indirect lighted Shutter control Dial for quick, accurate darkroom "feel". Illuminator separately adjustable for operator convenience and comfort.
New Drum-type Aperture. No edge fog from aperture wear. No adjustments required throughout life of film transport assembly.
Ball-bearing rotating shoulder supports edge of film opposite drive sprocket to transport film in flat, even plane past the aperture.
Tight Winds may be substituted for take-up flanges. Quick-interchange feature. When positive exceeds 1600 feet tight winds are recommended.
Push button control for simple ease of operation. START turns on the edge light, the shutter dial light, and (when used) turns on the sound printer lamp, applies low voltage to torque motors to gently take up slack in film and avoid snapping or breaking. RUN applies full power to drive motor and takeups. STOP shuts down entire equipment.
START
RUN
STOP
Work Table now swings to provide "L" shaped work area for more efficiency during printing.

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EVERY CONVENTION OFFERS AN OPPORTUNITY TO GREET OLD FRIENDS ...AND TO MAKE NEW ONES.

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SEE YOU IN L. A.!

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MARKETING MANAGER

Camera Equipment Co. Booth **211**
315 West 43 St., New York 36

Exhibiting: CECO Red Lake Projector; Weinberg-Watson Model II Projector; Cameraflex Boresight Camera and other photo-instrumentation cameras; CECO viewers; Waddell High-Speed Cameras; CECO motors; Scanascope Lenses; Professional Jr. Tripods—new models; portable power supplies; Maurer Blimp; Perfectone Recorder; CECO Programmer.

Personnel: Frank Zucker, Burt Zucker, Allan Green, Jack Pill, Cliff Van Praag.

Computer Measurements Co. Booth **119**
12970 Bradley, Sylmar, Calif.

Exhibiting: Unicorn Automatic Solvent Film Cleaner for 70mm film; Unicorn Automatic Darkroom Film Splicers 16mm, 35mm and 70mm models; Unicorn Color Timer for pre-selecting correct color printing filter information; Unicorn Printer Robot for Bell & Howell Printers (automation through programming tapes): Unicorn High-Speed Film Slitter for 35/32mm film.

Personnel: J. L. Cassingham, Mel W. Jones, Harlan Baumbach.

Electronic Systems, Inc., Hurletron Booth **204**
Subsidiary of Electric Eye Equipment Co.
1938 East Fairchild St., Danville, Ill.

Exhibiting: HURLETRON Automatic Shutter for 16 & 35mm Bell & Howell Printers; HURLETRON Punch Tape Control System With Tape Verifier; HURLETRON Automatic Control Board System; Dial-Matic Perforator.

Personnel: Theodore W. Batterman, Edward Richter.

Equipment Papers and Demonstrations

Wednesday, May 4, 9:30 a.m. to 12:30 p.m., exhibitors will present the following equipment papers and demonstrations. A complete list will be published in the Convention Program.

Bell & Howell Co.: The New JM Printer.

Florman & Babb, Inc.: F & B Power Mite Nickel Cadmium Batteries and Power Supplies With Transistorized Inverters.

Hollywood Film Co.: HFC 16mm Hot Splicer.

Mole-Richardson Co.: Special Effect Equipment—Cobweb Spinner, Fogmakers, 18-in. Windmaker.

Ryder Sound Services, Inc.: The New Perfectone and Accessories, the Ryder Sync Camera Drive, and the Ryder Transistorized Inverters.

S.O.S. Cinema Supply Corp.: Time-Delay Unit for Motion-Picture Printers.

Traid Corp.: AUTOMAX—35mm Data-Recording Camera.

Florman & Babb, Inc. Booth **202**
68 West 45 St., New York 36

Exhibiting: F & B Triplex Animation Stand; a new product for camera animation work; complete line of F & B products—and a few new ones.

Personnel: Arthur Florman, Warren Portman.

Great Books of the Western World Booth **108**
3805 Beverly Blvd., Los Angeles 4

Exhibiting: GREAT BOOKS, presented by Encyclopaedia Britannica in collaboration with the University of Chicago. The accumulated wisdom of three thousand years of civilization together with the revolutionary idea-index called the SYNTOPICON. These books bring together the greatest minds and ideas spanning the thirty centuries of Western civilization.

Personnel: S. R. Wallis, John Parker.

Karl Heitz, Inc. Booth **222**
480 Lexington Ave., New York 17

Exhibiting: Kinoptik High-Speed Color-Matched (T-Stopped) Apochromat Lenses, for 16 & 35mm motion-picture and television cameras from 20 to 500mm; Robot 35mm Automatic System Camera and complete electric photo-recording system; Alpa 35mm Single-Lens Reflex Camera; Sinar 8 × 10, 5 × 7, 4 × 5 Interchangeable View Camera; Lindia 2 × 2 snap-in mounts with Newton-free glass.

Personnel: Karl Heitz, Dean Peck.

Hi-Speed Equipment, Inc. Booth **215**
73 Pond St., Waltham, Mass.

Hollywood Film Co. Booths **121, 123**
956 N. Seward St., Hollywood 38

Houston Fearless Corp. Booths **112, 114**
11801 W. Olympic Blvd., Los Angeles 64

Lipsner-Smith Corporation Booth **217**
3475 West Touhy Ave., Chicago 45

Exhibiting: The Lipsner-Smith CF-2 Ultrasonic Film Cleaner. This cleaner differs from other cleaners in that there is no contact with the film while it is being cleaned and no mechanical scrubbing. The film is cleaned ultrasonically in a special CF-2 solvent bath and stripped dry in an air tower.

Personnel: Jerry Lipsner, Roy Bartels.

Magnasync Corporation Booths **104, 106**
5546 Satsuma Ave., North Hollywood, Calif.

Exhibiting: Magnasync 16mm portable recorders, Series X-400, 602, Mark IX; Magnasync 16mm and 35mm dubbers, interlock systems and studio mixing equipment; Nomad 7-lb transistorized split 16mm recording system.

Personnel: D. J. White, Bill Stutz, Ralph Sogge, Bob Dickinson, Jim Green.

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**To Webster it meant — the property of readily absorbing and retaining moisture*

To our industry, "Hygroscopicity" means trouble . . . trouble due to the fact that chemicals decompose and cake rapidly upon exposure to moisture.

We at L. B. RUSSELL CHEMICALS are proud that we have found the solution to this problem and can create a "Hygroscopicity-proof" lab with RUSSELL'S TROPI-PAK lined photographic chemicals- PH4 chemicals, which meet the Specifications of the American Standards Association.

TROPI-PAK, the heavy-duty Polyethylene liner, prevents Airborne Contamination, keeps out Harmful Moisture, insures that RUSSELL chemicals remain undecomposed —"Photo Grade."

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Canada: L. B. RUSSELL CHEMICALS (CANADA) LTD.
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J. G. McAlister, Inc. Booth **120**
1117 N. McCadden Place, Hollywood 38

Exhibiting: Fisher Microphone Boom, with crab base; Garnelites, stands, converters; McAlister Lights Dimmer, Duro, Diffusion Scrims; McAlister Crab Dolly.

Personnel: Walter A. Klinger, James L. Fisher, "Slats" Combs, Irving Yates, K. D. Clardy.

D. B. Milliken Co. Booth **117**
131 N. Fifth Ave., Arcadia, Calif.

Mole-Richardson Co. Booth **207**
937 N. Sycamore Ave., Hollywood 38

Exhibiting: Special effect equipment for motion-picture and television studios: Type 1963 Fogmaker Moleffect; Type 1983 Mister Fogmaker Moleffect; Type 1993 Senior Fogmaker Moleffect; Type 1911 Cobweb Spinner Moleffect; Type 1971 Windmaker Moleffect.

Personnel: M. A. Hankins.

Moviola Mfg. Co. Booth **110**
1451 Gordon St., Hollywood 38

Neumade Products Corporation Booth **219**
250 West 57 St., New York 19

Exhibiting: Video-tape storage cabinets; splicers, rewinds and other editing equipment for 16mm, 35mm, 70mm; Neuvator Film Cleaner; Neucue Television Cue Punch; Magnetic Tape Storage Units; film, filmstrip and slide cabinets and racks.

Personnel: Lee E. Jones, Robert E. [illegible]apel, Lew Grofsik.

Precision Laboratories Div. Booth **205**
Precision Cine Equipment Corp.
1037 Utica Ave., Brooklyn 3, N.Y.

Exhibiting: Precision Sound Readers for editing optical or magnetic soundtracks; unitized synchronizers; magnetic attachments for synchronizers; film slitters; editing devices for picture and sound.

Personnel: Irwin R. Sheldon.

Prestoseal Mfg. Corp. Booth **220**
37-27 33 Street, Long Island City 1, N.Y.

Exhibiting: New Prestoseal equipment for splicing dissimilar materials with thermal setting reinforcing agent; 16mm, 35mm and 70mm butt-weld splicers; digital paper tape splicer.

Personnel: Leonard A. Herzig.

Radio Corp. of America Booths **101, 103, 105,**
Broadcast & TV Equipment Div. **107, 109, 111,**
Camden, N. J. **113**

Exhibiting: RCA Television Tape System, featuring a "matched" line of production equipment; Advanced Television Tape Recorder; New 4½-in. Image Orthicon Television Camera; TK-15 Vidicon Television Camera; transistor switching

Modern as tomorrow and streamlined for maximum efficiency, the **ALL NEW** OXBERRY 1500 Series Optical Step Printer is a truly remarkable machine. Designed to meet the growing demand for a high performance, moderately priced unit, it embodies all the essentials necessary for fine optical printing and special effects work. It is built with the same high precision as the world-famous OXBERRY 1000 Series, but at a substantial lower price without sacrifice of function or scope.

The 1500 will do frame to frame and continuous step projection printing; freeze frame work; in color or black

New 1500 Series Printer

and white. Zoom range from 5 diameters reduction to 4 diameters enlargement. Both camera and projector will receive 35mm and 16mm components without loss of optical centers or film alignment when changing from 35mm to 16mm. Electro-mechanical drive has push-button controls. Full range of accessories available.

Standard model printer for 35mm includes the following: Camera with manual dissolve and fade; 35mm shuttle and sprocket assemblies; automatic take-up; 400 ft. magazine; counter; viewing device, superimposed type; precision compound lens mount; 100mm f/4.5 Ektar lens. Two speed stop motion motor, continuous, forward and reverse. Price, complete **$14,800**

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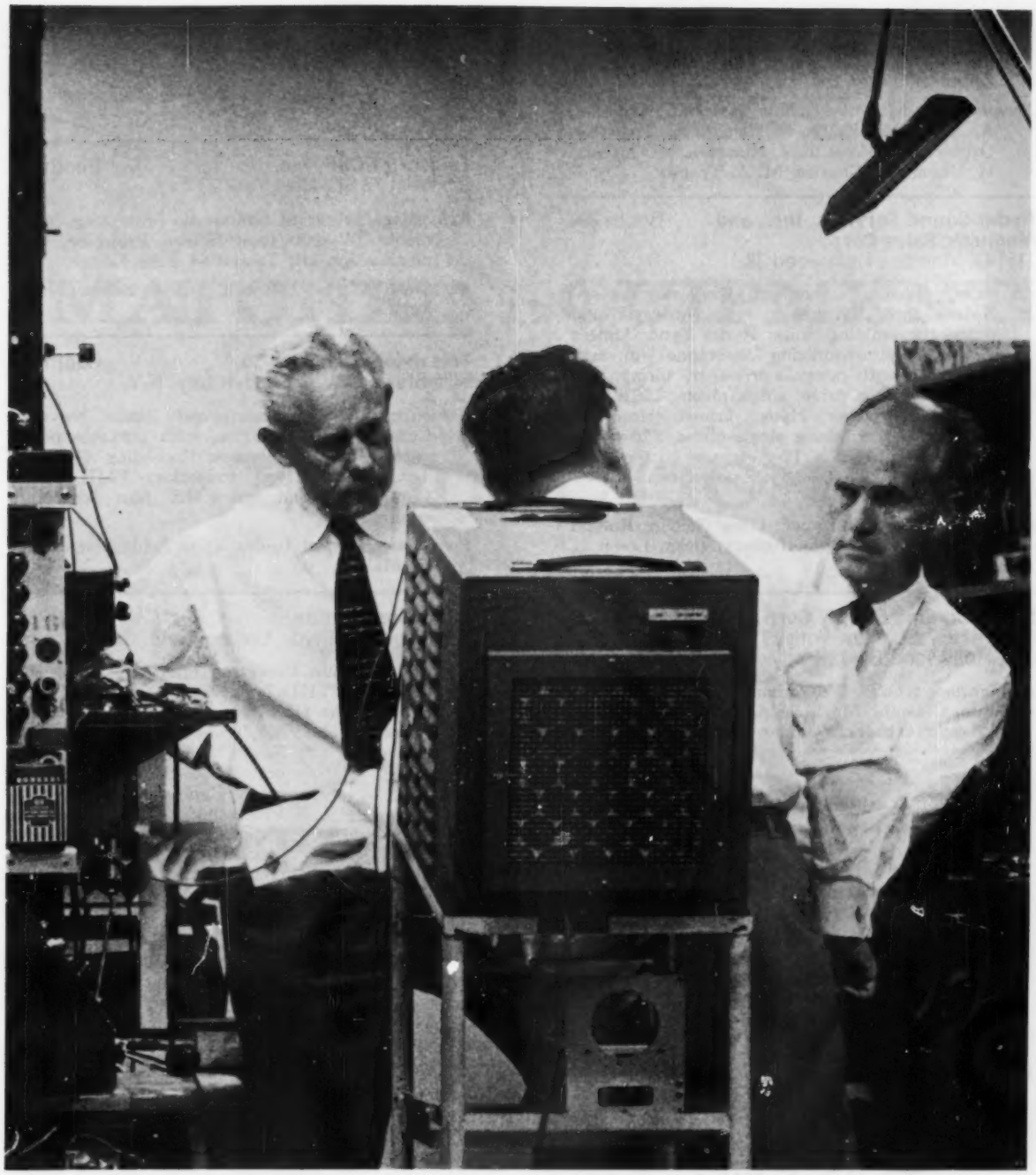

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Solving problems related to all types of film processing is their business. Out of their discussions also come ideas for saving you time—and money. Forty-five years of experience mean superior quality and service—plus dependability.

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and processing equipment; special effects for television tape production; editing equipment for television tape; audio and film recording equipment.

Personnel: A. M. Miller, Dana Pratt, P. Bergquist, A. E. Inglis, E. T. Griffith, Max Berry, J. Grever, E. J. Frost, R. J. Newman, M. Corbett, H. Dover, W. Charles, M. A. Trainer.

Ryder Sound Services, Inc., and Magnetic Sales Corp. Booth **209**
1161 N. Vine St., Hollywood 38

Exhibiting: New Perfectone and accessories: transistorized three-dial mixer, sync generator and automatic starting units; Ryder Sync Camera Drive: for synchronizing Perfectone ¼-in. tape recordings with cameras driven by spring, battery d-c motor drive, single-phase, 120-v and three-phase power; Ryder Transistorized Inverters: for furnishing single-phase, 120-v, 60-cycle power from a 12-v storage battery and three-phase, 220-v, 60-cycle power from a 24-v storage battery.

Personnel: Leon D. Selznick, Gene Garvin, Ronald Cogswell, Fred Albin, Robert Hicks, Loren L. Ryder.

S.O.S. Cinema Supply Corp. Booth **203**
602 West 52 St., New York 19
6331 Hollywood Blvd., Hollywood 28

Exhibiting: S.O.S. Tel-Anima Negative/Positive Film Cleaning Machine; S.O.S. Tel-Anima Hot Press; S.O.S. Sonostriper: Moy Visible Edge Numbering Machine; S.O.S. Ediola Film Viewers; Bridgamatic Processing Machine; Tel-Amatic 16mm Printer.

Personnel: D. J. Capano, Alan C. Macauley, Jan Macauley.

Telescript-CSP, Inc. Booth **213**
155 West 72 St., New York 23

Exhibiting: Telescript film studio prompting equipment; TV-7000 Rear Screen Projector, with polarization kit; Television Tape Editor.

Personnel: Curtis Howard, David Reiner, J. P. Latil.

Television Specialty Co. Booth **206**
1055 Stewart Ave., Garden City, N.Y.

Exhibiting: TSC Transistorized 16mm Newsreel Cameras, sound-on-film, with portable power pack; TSC Kinescope Recording Cameras; TSC Rear Screen Projector; FME 35mm Cameraflex Camera: FME film inspection equipment.

Personnel: Howard Ryder, John Schlageter, James K. Malone.

Traid Corporation Booth **218**
17136 Ventura Blvd., Encino, Calif.

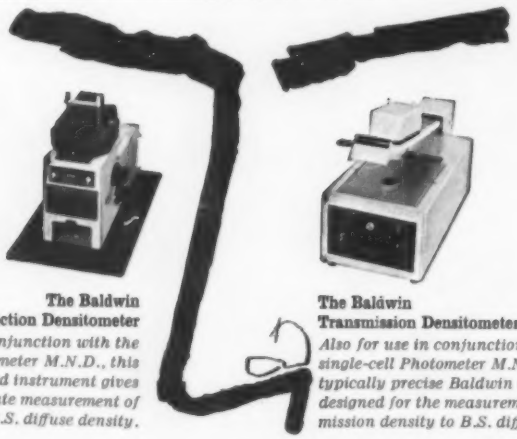
Exhibiting: 16mm Cameras: Traid 15, Traid 560, TKB-3A, TKD-7, TKS-27A, 917F. Photo-Sonics 16mm-1B, Photo-Sonics 16mm-1C; 35mm Cameras: Traid 805, Traid 75, Automax, Photo-Sonics 35mm-4B; 70mm Camera: Photo-Sonics; Miscellaneous: Raproroll (Rapid Film Processing), lenses, splicers, Vanguard Reader, magazines, tracking finders, power supplies, converters, intervalometer, digital recording devices, boresights etc.

Personnel: Carlos Elmer, Robert King, Arthur H. Bolt, R. F. Peterson, Dick Freeborg, Fred G. Roberts, Jr.

Westrex Corp. Booths **116, 118**
6601 Romaine St., Hollywood 38

Exhibiting: Latest Westrex Multi-Unit Rerecorder and Transistorized Rerecording Mixer; model of new Automatic Announcing System and Message Synthesizing Unit; model of new Electro-Mechanical Reverberation Synthesizer; latest Westrex StereoDisk Recorder equipped with an Automatic Variable Depth Control.

Personnel: Leo A. Call, Ed A. Dickinson, Frank E. Pontius, Bill A. Findlay, Fred Harney, Frank O'Brien, Ralph W. Wight.



The Baldwin Reflection Densitometer
Used in conjunction with the single-cell Photometer M.N.D., this easily operated instrument gives an accurate measurement of B.S. diffuse density.

The Baldwin Transmission Densitometer
Also for use in conjunction with the single-cell Photometer M.N.D., this typically precise Baldwin instrument is designed for the measurement of transmission density to B.S. diffuse density.

The infallible eyes

As the techniques of photometry and densitometry become more and more complex, the comparison between prints or negatives cannot rest on the judgement of the human eye, however well experienced. Today, the unvarying accuracy of Baldwin instrumentation is needed.

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Write for Brochure JMP/117 containing details of the complete Baldwin range.

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We think this represents the finest and most complete demonstration of TV Tape Equipment ever presented. You'll see the only "matched" line of program production equipment. You'll see the latest in Advanced Recording, Special Effects, Transistor Switching, and TV Cameras for Tape. You'll see pictures that sell themselves to sponsors because they're above and beyond anything yet offered . . . pictures that make multiple copies because they are so sharp. You'll see the sharpest pictures in town!

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BROADCAST AND TELEVISION EQUIPMENT • CAMDEN, N.J.

Control Techniques in Film Processing

The manuscript for this book is the result of nearly two years of concentrated effort on the part of a special subcommittee of the SMPTE Laboratory Practice Committee. Subcommittee Chairman is Walter I. Kisner whose monumental contribution includes acting as coordinator and editor of the book. Publication has been scheduled for May 1960. It will be a first-class book, in both appearance and content, a book of which the Society will be proud. Printed on first-quality coated paper, with a sewed binding and board and cloth covers, with aluminum stamping on spine and front, its "dress" is designed as an appropriate indication of the quality of its contents. The book contains 73 illustrations.

Each of the 10 chapters is written by a recognized specialist in some definite phase of film processing. The subject matter is of basic interest to everyone engaged in film processing in laboratories serving motion-picture, television and the many specialized fields such as high-speed and instrumentation photography.

Project's history and purpose: In the Foreword, E. H. Reichard, Chairman of the SMPTE Laboratory Practice Committee, discusses the history and purpose of the book and points out that it "is not intended to be a handbook of instructions; instead, it is aimed toward furnishing a firm foundation for the understanding of proper process control techniques and to provide a guide for further work and study." The Foreword also brings out the great need within the industry for this book, which may be regarded as the first authoritative work in this field and a work which will have enduring value.

Following are the chapter titles with a brief description of the contents.

Chapter 1: Introduction

It is the responsibility of the laboratory to provide day-to-day repeatability of processing and high quality end results if patronage and good will are to be maintained. Every motion-picture material handled by a laboratory deserves utmost respect if the final product is to be acceptable. A short discussion is given on the differences between processing of still films and motion-picture films. The basic tools needed to evaluate and control processing are indicated and the material to be covered in subsequent chapters is outlined.

Chapter 2: General Principles of Process Control

This chapter deals with the general philosophy and basic principles underlying effective process control. The control of any process is comprised of three phases (1) process specification, (2) process evaluation and (3) diagnosis and the removal of causes of poor operation. A division of the photographic control problem into these three phases and serious attention to providing adequate performance in each, helps to simplify and organize the work. The statistical nature of data derived in control procedures needs to be recognized and forced upon the attention of the operators by control chart techniques, thus avoiding over-control.

Chapter 3: General Aspects of Motion Picture Film Processing

This chapter serves as background material for the newcomer to the field of motion-picture processing. It outlines the various types of processes required for the different production systems and the individual phases thereof. It also emphasizes the need for process control for these individual phases, preparing the way for the more detailed information given in later chapters.

Chapter 4: Mechanical Evaluation and Control

The important factors to be considered in providing proper mechanical control of processing are discussed. The selection and maintenance of instruments for control of each of these factors is then presented. Finally, the importance of careful correlation of mechanical control data with chemical and photographic control data is stressed.

Chapter 5: Instruments for Photographic Control

A general discussion of the photographic control method is given and the importance of making picture tests in helping to establish the proper limits for sensitometric control is pointed out. The basic features of control instruments, namely, sensitometers and densitometers, are described and examples of commercially available instruments are shown. The proper maintenance of these devices is outlined; such maintenance is stressed as an essential task if the sensitometric data is to be relied upon.

Chapter 6: Control Strips and Sensitometric Curves

The selection and storage of control strips is first considered and the factors influencing the frequency of control tests are discussed. The remainder of this chapter is devoted to the graphical representation of sensitometric data in the form of the classical D-log E curve. The determination of various parameters such as gamma, speed, fog, latitude and total scale is then described in detail.

Chapter 7: Sensitometric Control of a Standardized Process

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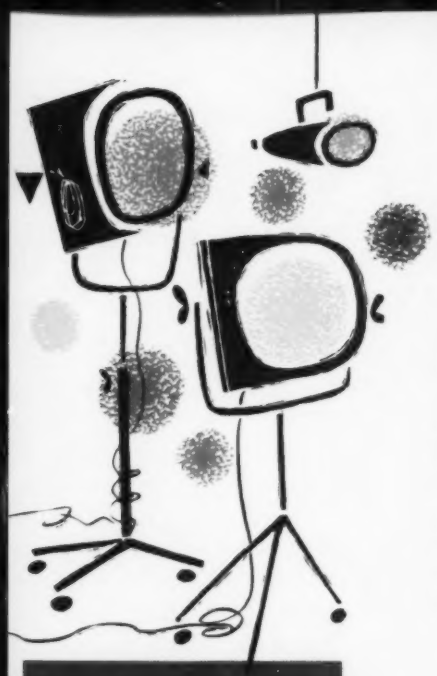

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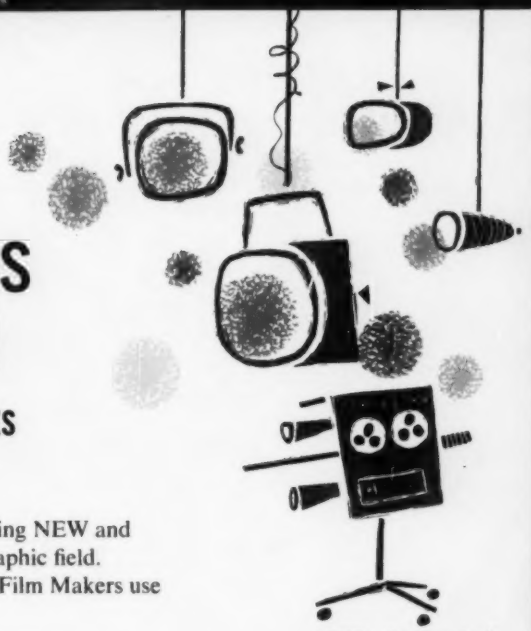

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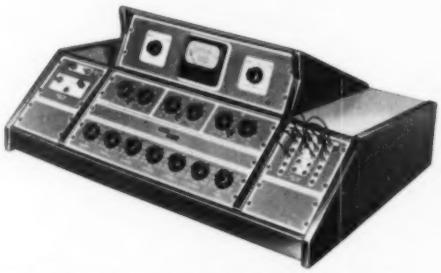

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given for establishing a standard process. To simplify the obtaining and plotting of data from the sensitometric control strips, selected densities of only certain steps of the strips are plotted on the control chart. The tolerance limits for the control chart are determined on the basis of what is considered reasonable from subjective judgments of picture and sound quality.

As a guide for establishing suitable limits, tolerance values for gamma and density for various classes of materials are stated, these limits being representative of those used by well-operated laboratories. Pertinent information is also given with respect to control of duplicating and sound recording processes. Some miscellaneous tests which make use of sensitometric techniques are also described.

Chapter 8: Chemistry of Film Processing

This chapter will be of greatest importance to those familiar with the science of chemistry, but will also be helpful as a reference for others. It covers the chemicals used in processing and the influence of the individual ingredients of a solution on the photographic result. The influence of temperature and pH of solutions is also described.

Chapter 9: Chemical Analysis and Control

The facilities and instruments needed for a chemical control laboratory are described. An extensive table listing sources of information on analytical methods is given. Information is given on recording of data, establishment of chemical control limits and practical formulation of replenishers. In the final section, some practical suggestions pertaining to the control of reversal processes are presented.

Chapter 10: Economic Considerations in Establishing a Process Control System

This brief chapter attempts to answer questions pertaining to the economic value of a process control system to a given laboratory, how much it should cost and if the cost is too high.

Conclusion

Concluding remarks stress the importance of applying the principles outlined in an effort to raise the quality level of processing throughout the industry.

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The sales price of *Control Techniques in Film Processing* is not yet fixed: It will be modest and there will be discounts for SMPTE Members and a scale of discounts for large-lot sales. If there is a demand for large lots by *cinema laboratories* and *equipment distributors* an arrangement for special binding with company imprints may be provided at about $20.00 additional for the first 100. Expressions of interest will be welcomed by the Editor at Society Headquarters.

Obituary

John G. Capstaff

A distinguished pioneer in color photography, John G. Capstaff, 80, died January 31, 1960, at his home in San Diego, Calif. He was a native of Newcastle, England, and as a young man he did portrait photography. He came to the United States in 1913 to accept a position with Eastman Kodak Co. and was one of the first members of the Research Laboratories.

He had been associated with Eastman Kodak for 42 years at the time of his retirement in 1954. During that time he was granted more than 60 patents, many of them in the field of color photography. His improvement of the reversal process is credited with bringing the making of motion pictures within the reach of amateurs and hobbyists. His research contributed greatly to the development of the lenticular process of color photography on 16mm film which was placed on the market in 1928.

Many honors accrued to him during the course of his long and creative career. He was made an Honorary Member of the Society in 1955 (*Journal*, p. 689, Dec. 1955). He was an Honorary Fellow of the Royal Photographic Society of Great Britain and of the Photographic Society of America. In 1944, he was the recipient of this Society's Progress Medal. Among other awards he was recipient of the Modern Pioneers Award of the National Association of Manufacturers in 1940 and in 1946 was awarded the Progress Medal of the Royal Photographic Society of Great Britain. Following his retirement a biography by R. G. Tarkington was published in the *Journal* (Aug. 1954, p. 68).

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Education, Industry News

A new SMPTE Student Chapter has been established at Boston University. Faculty Advisor is Alexis E. Ushakoff, Jr., who teaches in the School of Public Relations and Communications. Student Assistant Advisor is Dave Nohling. With this Chapter five Student Chapters have been established. The others are: City College, New York; Rochester Institute of Technology; Univ. Southern Calif; and Univ. of Miami.

The International Commission of Optics has announced a Summer School to be held July 4-13 in Paris, France. About 24 to 30 lectures and seminars will be held centered around the general subject of Modern Aspects of the Theory of Formation of Images. Purpose of the school is to provide information to students and advanced research workers on the present situation of the theory of images, the use of Fourier techniques, the evaluation of optical images, etc. Further information is available from Professor A. Maréchal, Institut d'Optique, 3 Boulevard Pasteur, Paris 15, France, or from the chairman of the U. S. National Committee of the ICO, W. L. Hyde, c/o J. W. Fecker, Inc., 6592 Hamilton Ave., Pittsburgh 6, Pa.

Plans for converting a 78,000-sq ft hangar at the Isla Grande Airport, San Juan, Puerto Rico, to a major television and motion-picture studio have been announced, the space having become avail-

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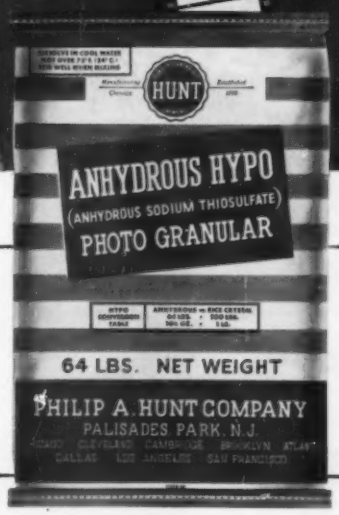

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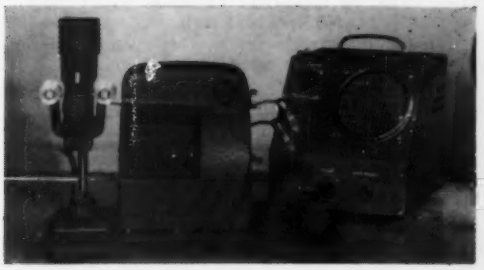

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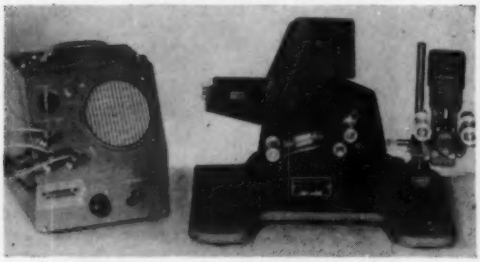

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able because of the construction of the new International Airport at Isla Verde. The hangar has been leased by the Richport Amusement Corp. from Puerto Rico Ports Authority. The corporation, which has an authorized capital of $3 million, is headed by Hal Roach, Sr., who plans to operate the studio. Construction work is expected to begin in May.

The 20th Annual National Audio-Visual Convention will be held August 6–9 at the Morrison Hotel, Chicago. The theme will be "The Challenge of the Sixties." The Convention and Exhibit is expected to bring together more than 2500 people from the audio-visual field. Further information is available from NAVA, Fairfax, Va.

A multiple-camera technique for filming live, unrehearsed panel discussions, business conferences and similar situations has been announced by Wilding, Inc., 1345 W. Argyle St., Chicago. The process, called Communi-Cam, employs two or more cameras synchronized and set in motion from a central control point and operated independently by separate crews. Use of film permits editing out irrelevant portions of a discussion.

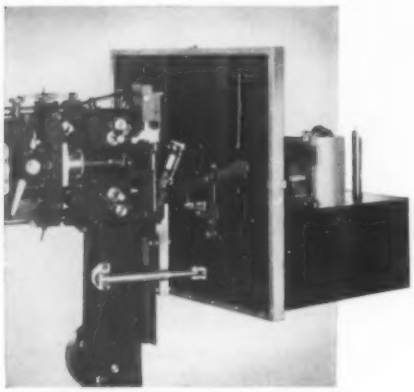
As the printing press made obsolete the craftsmen who lettered and bound the missals of the Middle Ages, so may the electronic computer make obsolete the editors and scholars whose specialty is the preparation of concordances. At Cornell University, Ithaca, New York, a Concordance to the Poems of Matthew Arnold (975 pages of print, plus an appendix; 70,000 references, and the occurrence of 10,097 words of the poet's vocabulary) was prepared with "dazzling speed" by using an electronic computer which reads at the rate of 15,000 characters/sec and makes 42,000 logical decisions/sec. In announcing publication of this volume the Cornell University Press said that the "flawlessly correct machine-brain system of editing paves the way for the editing and printing in a matter of hours of monumental volumes that formerly involved painstakingly long and detailed years of work by many editors and technicians." Each great invention adds something, but is also subtracts and until the final totting up of the column no one knows what the sum may be. There is an uneasy suggestion in announcements of this sort that the human brain may soon become obsolete, useless for almost every kind of activity except contemplation.

In October 1958, the Education, Industry News column of the *Journal*, which is permitted either one coruscating or two mild jokes each year, made one of its mild jokes (p. 698). In reporting the possible development of a process of releasing appropriate scents during motion-picture showings "to heighten audience identification", the column commented jovially, "Chanel No. 5 might be used for 'high-society'-type romances and perhaps a lovely combination of tar and bilge-water for *On the Waterfront* type dramas." Jokes? At this writing, the motion-picture *Behind the Great Wall* is showing in New York theaters and according to the (mostly favorable) reviews, the smells are most realistic. An interview with perfume chemist Selma Weidenfeld who worked on Aromarama, as the new process is called, was reported in the *New York Herald Tribune*, Dec. 3, 1959. She produced a river smell by mixing "roots, mosses and a synthetic ozone." (The inspiration for next year's Hit Parade song, *Smell Me a River.*) She also was required to create a smell identical with that of a trapped tiger. "A trapped tiger," she said, "smells subtly different from a tiger at large, and a whole lot different from the tiger house in the Zoo."

Since last year's joke may become next year's reality, the Education, Industry News column is duly warned to watch out for these "smelly" jokes.

A comprehensive revision of American Standard PH2.5-1954—Method for Determining Photographic Speed and Exposure Index, is expected to be approved and published in the near future, according to the *ASA Newsletter* for January. The exposure index for black-and-white film has been criticized for some time because of the "safety factor" which has been deemed outmoded by continuing developments in photographic techniques. The proposed new standard will reduce the safety factor from about 2.5 to about 1.2 (the same as for color film), set up new methods for determining sensitivity of photographic negative material, and give a new logarithmic scale for expressing film speed.

The elimination of the safety factor means that black-and-white film presently rated ASA 50 will be rated ASA 100.



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Solenoid operated, calibrated neutral density glass filters. Five filters in each color beam, giving 32 printer steps of .025 or .030 Log E.

High efficiency interference-type dichroic beam splitters to form a single mixed output beam.

Colored glass and/or high efficiency interference-type trimming filters, "peaked" to the positive stock sensitivity.

Printing speed up to 125 feet a minute for continuous printing; 55 feet a minute for step printing.

Three 750-watt bulbs, operating at 60–80 volts. Assures long bulb life, saving time in calibration.

Adjustable lamp sockets to line up filaments. Three degrees of freedom; vertical, rotational, lateral.

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3-Channel Memory Unit with Reader for automatic operation of flipper assembly, reading in succession blue, green, red and storing the introduced information. 15 neon pilot lights indicate when the 15 neutral density filters are in or out so that operator can see at a glance if Reader and Memory Unit are functioning properly. For easy servicing, commercially available punched tape reader is used as a base. Price: $3,200 F.O.B. New Rochelle, N. Y.

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Price: $2,300 F.O.B. New Rochelle, N. Y.

Write for further information

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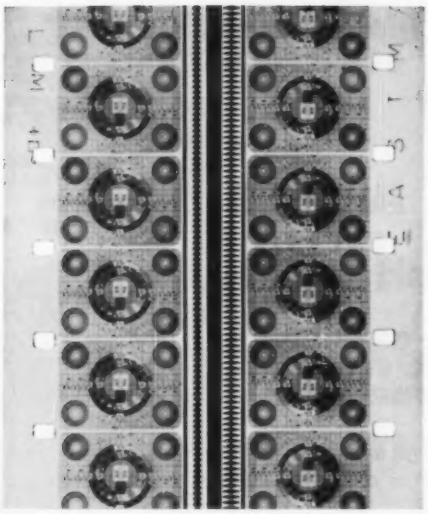

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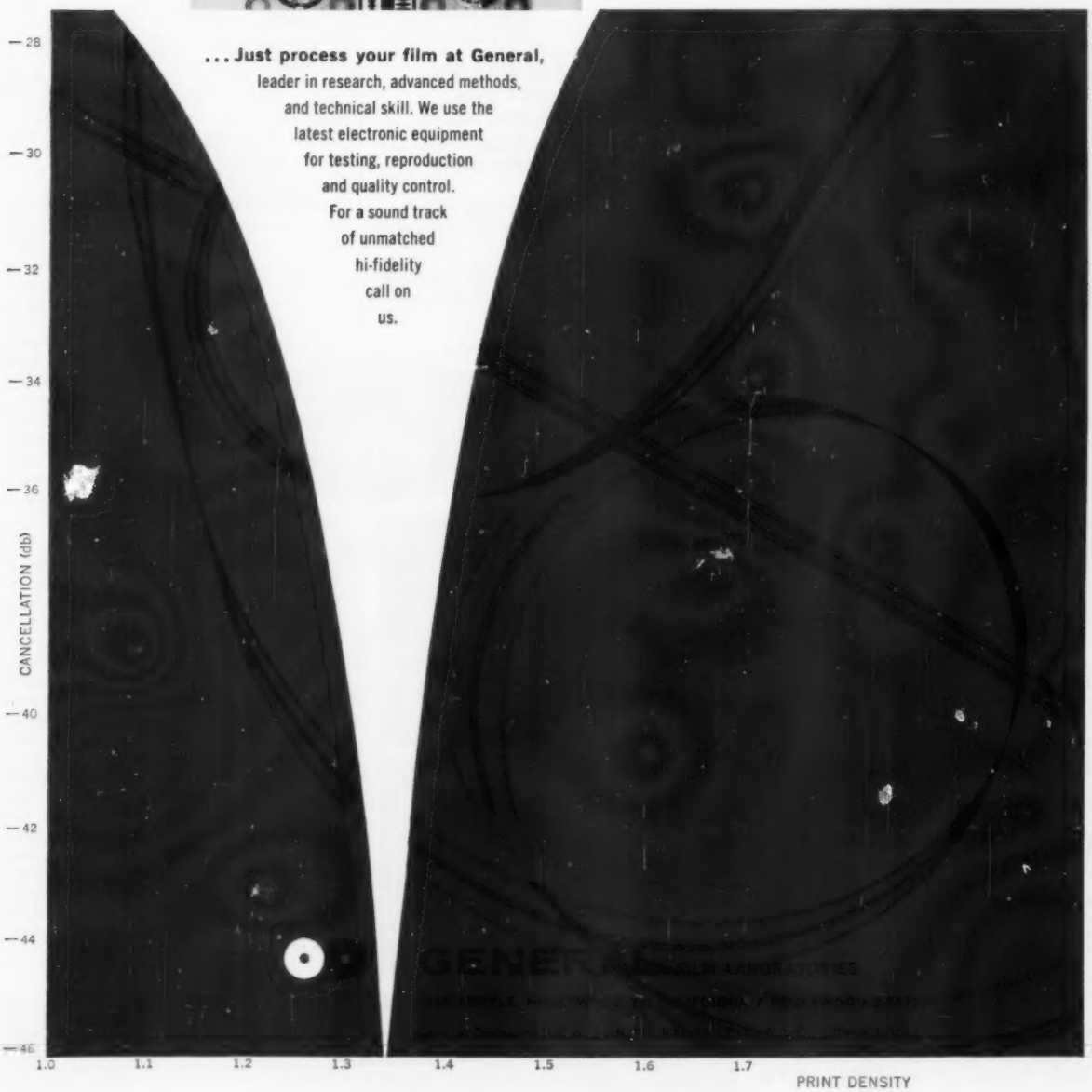

The Answer to Zoom & Telephoto Lens Tripod Problems

SILICONE DAMPENED 'HYDROFLUID' BALL-LEVELING PAN & TILTHEAD TRIPOD

Precision construction—positive quick-finger camera lock—variable tension adjustment pan and tilt locks—spirit level—telescopic pan handle with variable angle adjustment—right or left hand position.

INTRODUCTORY PRICE $329.50
Complete With Tripod Legs

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- Designed for professional cameramen.
- Velvety smooth, jerk-proof pan and tilt action, utilizing the dampening effect of silicone.
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- Silicone loaded—temp. range 130 + 500F.
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- First tripod of its kind with ball-type leveling at bottom of base with positive lock at NO EXTRA CHARGE.
- Tripod base of seasoned V-type maple-wood legs with self-aligning leg locks.
- For all cameras 40 lbs or less.

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for Cine Special and Maurer Cameras

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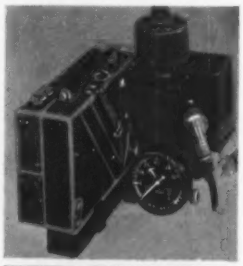
- VARIABLE SPEED 8-64 FRAMES
- ADAPTER FOR MAURER CAMERA



Interchangeable Motors: 12-V DC variable Speed 8-64 Frames. 115-V AC 60 Cycles, Synchronous Motor, Single Phase. 220-V AC 60 Cycles, 3 Phase, Synchronous Motor.

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There will be no changes in color film ratings. The new logarithmic scale will use unit numbers from 0° to 11°. A step from one number to the next doubles the speed. For example, ASA 25 will be (logarithmic) ASA 3°, and ASA 50 will become ASA 4°.

A recent publication bearing on this subject is "Safety Factors in Camera Exposures" by C. N. Nelson in *Photo. Sci. & Eng.*, pp. 48–58, Jan.-Feb. 1960.

The Cinemiracle process developed by National Theatres and Television, Inc., has been purchased by Cinerama, Inc., according to a joint announcement by B. Gerald Cantor, President of N.T.&T., and Hazard E. Reeves, President of Cinerama. The Cinemiracle process was introduced in April, 1958, with a simultaneous showing in New York and Hollywood theaters of the picture *Windjammer*. With this process, a picture composed of three prints synchronously projected side by side is shown on a deeply curved screen. The purchase price is said to be more than $3 million.

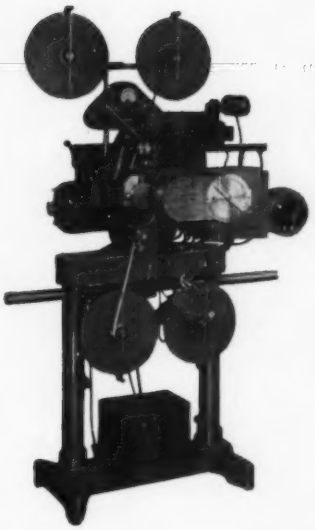
An earlier announcement (*Journal*, p. 78, Jan. 1960) revealed an agreement between Loew's, Inc., and Cinerama, Inc., for the production of feature-length films in the Cinerama process.

The 1st International Congress on Medical Photography and Cinematography will be held in Cologne, Germany, Sept. 27–30, under the auspices of the Deutsche Gesellschaft für Photographie e.V. Topics under the general subject of Photography in Medicine will include Endophotography, Macrophotography, Microphotography, X-ray Photography and Operation Photography. Under Cinematography will be included the topics of Endocinematography, Macrocinematography, Microcinematography, X-ray Cinematography, Sound Technique and Lighting Technique. A number of papers by well-known scientists from various European countries are scheduled for presentation.

The Third International Conference on Medical Electronics will be held in London, July 21–27, 1960. The meeting is being organized by the Electronics and Communications Section of the Institution of Electrical Engineers and the International Federation for Medical Electronics. Papers to be presented are grouped in four broad categories: Research and Advanced Development; Survey Papers; Integrating Papers which present a critical view of developments in a field, and Medical Electronic Engineering Practices and Achievements. Session topics include Ultrasonics, Isotopes and Radiology, Electronic Aspects of Human Engineering, and Medical Electronics in Space Research. Program coordinator in the United States is Lee B. Lusted, M.D., Department of Radiology, Univ. of Rochester School of Medicine, Rochester 20, N.Y.

The 29th Annual Meeting of the Inter-Society Color Council will be held at the Philadelphia Museum College of Art, Philadelphia, April 11 and 12, 1960. Meetings of color problems subcommittees

New High Speed PETERSON Model 16-C-100



Single Head 16MM Continuous Contact Picture and Sound Printer

The NEW PETERSON 16MM CONTINUOUS CONTACT PRINTER has been designed to produce quality print at a new printing speed of 144 feet per minute.

A new type of aperture and film printing gate has been designed.

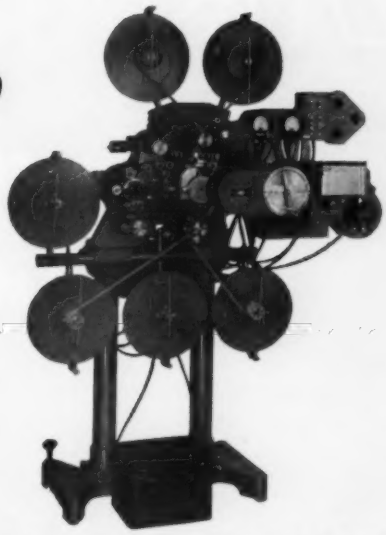
A precision contact roller is used rather than a shoe.

A new type of film support is used to carry the film edge of the sound side over a rolling drum, whereby perfect contact is obtained between the negative and positive print.

This printer is available with either a Semi-Automatic Light Control, or with a Fully Automatic Light Control.

New PETERSON Model 16-C-100

Double Head Contact Printer



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Can be equipped with Fully Automatic Light Control Shutter and built-in Automatic Fade Unit.

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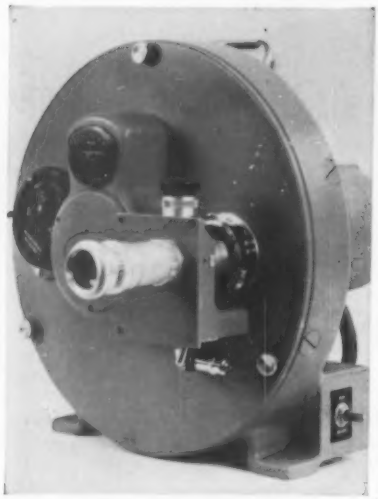

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will be held April 11. An especially interesting Symposium will be held April 12, in the afternoon, on "Creative Color." Speakers are Neil Welliver, Asst. Prof., Dept. of Art, Yale University; Lester Beall, Designer, Brookfield Center, Conn.; and Robert Riley, Director, Industrial Research Division, Brooklyn Museum. An illustrated lecture will be given the evening of April 12 by James J. Sweeney, Director, Solomon R. Guggenheim Museum, New York.

Refining Copper From the Sudbury Nickel Ores is a 39-minute film produced by Film Graphics, Inc., for the International Nickel Co. to dramatize the problems the copper refiner must solve in separating pure copper from molten crude blister copper. Filmed in Technicolor, the "sets" include the interiors of furnaces with temperatures ranging up to 2200 F, and industrial plant locations for such scenes as blister copper being poured directly from hot-metal cars into the giant anode furnaces, huge banks of casting wheels, and an electrolyte cell room covering more than four acres. Color rear-screen projection is used to give the viewer a sense of immediacy. All possible precautions were used to protect the camera and cameraman when photographing the interiors of the furnaces such as heat-absorbing glass and asbestos shields. Air hoses played cool air on the camera and lenses as they photographed hot-metal working and pouring operations. Prints are available without charge to science classes of high schools and colleges, industrial organizations and technical and engineering societies. The film was described in an article. "You have to SEE the Big Picture," in Issue Six, Volume Twenty, of *Business Screen Magazine*.

Research in radiophysics and other fields related to the study of space will be conducted at a newly created research center at Cornell University. Among the areas of research will be radio investigation of the atmosphere; space vehicle instrumentation for the study of gases in the solar system; radio investigation of the ionosphere and of the gases beyond the ionospheric layers; radar investigations of the planets; radio astronomy of galactic and extragalactic sources, and laboratory investigations pertinent to these sources. Thomas Gold, an internationally recognized cosmologist, has been named Director of the center. Associate Director will be Henry G. Booker, a leading scientist in theoretical research of electromagnetism and radio propagation.

The Standards Engineers Society, 1025 Connecticut Ave., N.W., Washington 6, D.C., was organized in 1947 with the aim of providing a means for standards engineers and others interested in standardization to exchange ideas in meetings and publications. Incorporated in 1956, the organization has a membership of over 900 in the United States and other countries. Publications include *Standards Engineering*, a magazine containing articles on standardization, and the *Proceedings* of each annual meeting. The last meeting was held in September in Boston, Mass. Membership is available in three grades, Member, Associate and Student. Two additional grades, Honorary Life Fellow and Fellow may be conferred by the Board of Directors.

Three new departments established by TelePrompTer Corp., 311 W. 43 St., New York 36, are: Research and Development; Programs and Production; and Communications Systems Division. Heads of the new departments (in that order) are: H. J. Schlafly, Jr., Edward Reveaux and Nat C. Myers.

Peachtree Production Associates, Inc. has moved its offices to Suite 217, 710 Peachtree St. N.E., Atlanta, Ga. The firm was formerly located at 220 Pharr Rd., Atlanta.

Acquisition of a new plant in West Los Angeles and the appointment of three new staff members to the West Los Angeles division as part of an expansion program has been announced by Houston Fearless Corp., 11801 W. Olympic Blvd., Los Angeles 64. Charles F. Andrews, former Production Manager for Consolidated Photographic Industries, has been appointed Manager, Photo Finishing Equipment Section. James Hannum and Howard Speer, both formerly with Hughes Aircraft Co., have been assigned to the Communications Research Group, Mr. Hannum as Manager and Mr. Speer as Senior Staff Engineer.

A suggestion that the services offered by the Engineering Societies Library, 29 W. 39 St., New York 18, are not being fully explored by many organizations and individuals who might benefit from them was made by Ernest Hartford, Director of Promotion, Engineering Index, Inc. (same address), in a speech before the Council of Engineering Society Secretaries. He said that 55,000 journals appear annually containing about 1,200,000 articles of significance for some branch of research and engineering. More than 60,000 books on some area of engineering are published each year and about 100,000 research reports remain outside the normal channels of publication and cataloging.

Even the compilation of these statistics represents a staggering task, and sifting the huge mountain for information in some specific context is beyond contemplation.

The *Engineering Index* (current issue 1958; 1959 edition scheduled for June 1960) sifts through this mountain to provide a guide to periodical technical literature. The volume is priced at $70.

The Engineering Library offers such services as translations, literature searches, bibliographies, and many others for nominal fees. A folder outlining these services is available without charge.

The Society of Photographic Scientists and Engineers will hold its Annual Conference May 9–13, 1960, at the Miramar Hotel, Los Angeles. Subjects to be explored in technical papers presented at the Conference will include optics, camera and equipment design, photosensitive systems, the use of photography in scientific and

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engineering recording and measurement, data acquisition and information storage and retrieval with photographic materials. Papers Chairman is John H. Jacobs of Consolidated Electrodynamics Corp., Pasadena, Calif.

A report from the National Educational Television and Radio Center, 10 Columbus Circle, New York 19, outlines a year of progress highlighted by a Ford Foundation grant, enabling the network to equip its member stations with video-tape recorders; a gift from Minnesota Mining and Mfg. Co. to provide for a basic supply of tape for network use; and a grant from the Ampex Foundation establishing a model video-tape duplicating center in Ann Arbor, Mich. The report is in the form of a 26-page illustrated brochure, entitled *1959 — Year of Progress*. The Center, now in its seventh year, has as its goal the broadly defined objective of promoting "the advancement of educational television and radio for the general welfare."

Highlights of the IRE International Convention held in New York, March 21–24, included a symposium on "Electronics — Out of the World" conducted by Ernst Weber, President, Polytechnic Institute of Brooklyn. Subjects of papers included: Intergalactic Data, Communication Relaying, and Design for Survival, among others. During the Convention about 275 papers were presented in 54 sessions. About $15 million worth of electronic equipment was displayed at the New York Coliseum for the Radio Engineering Show. Guest speaker at the opening meeting was Lloyd V. Berkner, President, Associated Universities, Inc.

The Rochester Institute of Technology Student Chapter has announced the First Annual Awards Competition for Student Technical Papers, cosponsored by the Chapter and Delta Lambda Epsilon(photographic fraternity). A joint meeting will be held May 19, 1960, at which the six papers judged the best of those entered in the competition will be read. The Chapter held its first meeting of 1960 on January 28. Fred Emens of Wollensak Optical Co. spoke on "High-Speed Cinematography in Science and Engineering." Conrad A. Strub is Program Chairman.

High-Speed Photographic Measurement Techniques will be the subject of a Seminar to be held at the Massachusetts Institute of Technology, Aug. 15–19. The program is under the direction of Prof. Harold E. Edgerton of the Dept. of Electrical Engineering. Topics to be discussed include stroboscopic lighting, optical high-speed cameras, Kerr cells, Faraday shutters, and image converters. In addition to the discussions there will be laboratory demonstrations of various types of high-speed photographic equipment. Further information is available from the Office of the Summer Session, Room 7–103, M.I.T., Cambridge 39, Mass.

The list of categories of films competing in the 1960 American Film Festival, sponsored by the Educational Film Library Association, 250 W. 57 St., New York 19, has been revised to include additional categories of scientific films. More than 500 films have been submitted with a marked increase over previous years of films on such subjects as astronautics and other areas of scientific interest. Two separate categories have been added to the Science and Mathematics category, making three in all. Competing films are now grouped in 34 categories arranged in larger groups under five main subjects: Education and Information: Art and Culture: Religion and Ethics; Business and Industry; Health, Education and Medicine. The 1960 American Festival juries will meet April 20–23 at the Barbizon Plaza Hotel, New York.

The Summer Instrument-Automation Conference and Exhibit of the Instrument Society of America will be held May 9–12 in San Francisco. A number of technical papers scheduled for presentation deal with control valve problems. A Session on Aerosols and Condensation Phenomena Measurement will be held in conjunction with the American Meteorological Society. Other sessions will be on Metals and Ceramics Instrumentation; Data Handling and Computation; Physical and Mechanical Instrumentation; and Feedback Control System. This will be the second ISA Conference and Exhibit held during 1960, the first having been held in Houston, Tex., Feb 1–4. The ISA International Conference and Exhibit, held in conjunction with the 15th Annual Meeting, will be held Sept.

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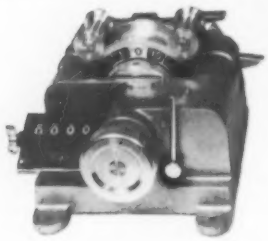

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Synchronizer $95.00
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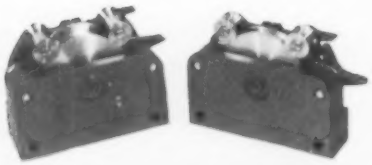

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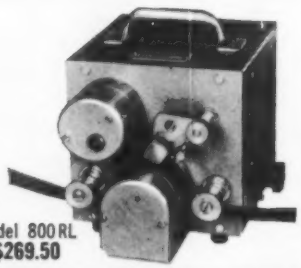

Model 800 RL
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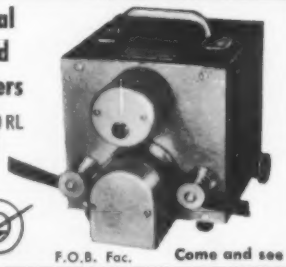
optical sound readers

Model 600 RL
$195.00



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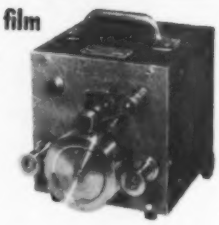

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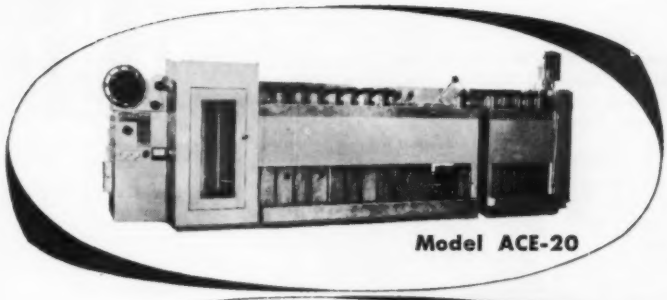
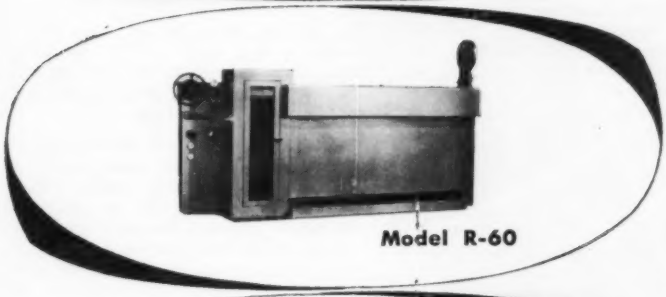


Model ACE-20



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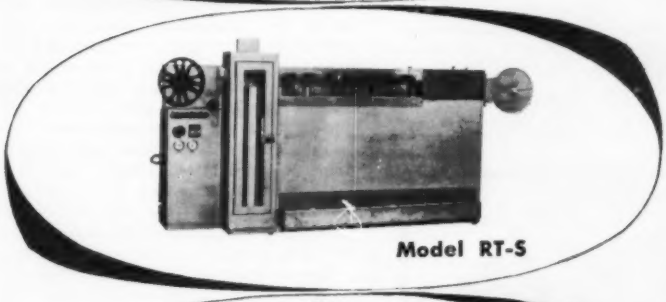
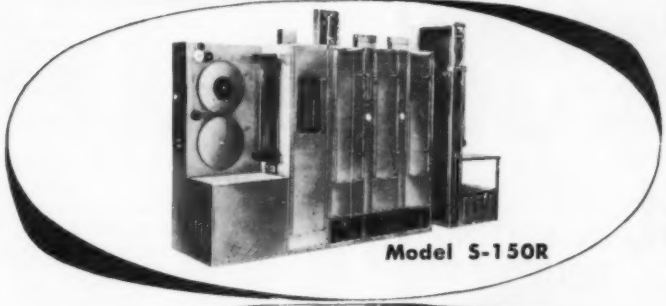
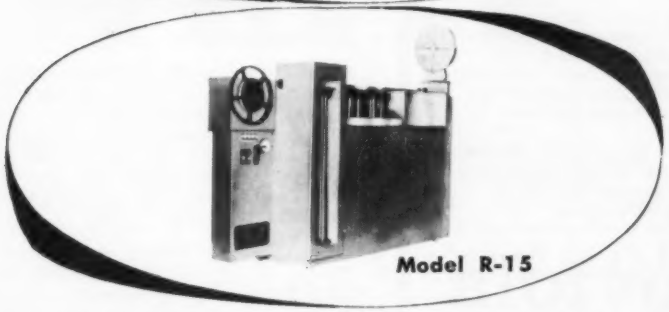


Model RT-S



Model S-150R



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316 D	Neg/Pos.	B&W	16mm	60 FPM
316 DS	Neg/Pos.	B&W	16mm	60 FPM
416 D	Neg/Pos.	B&W	16mm	80 FPM
N	Neg/Pos.	Microfilm	16/35mm	8 FPM
L	Neg/Pos.	B&W	16/35mm	8 FPM
RN 16/35	Neg/Pos.	B&W	16/35mm	24 FPM
RN 16/35mm	Neg/Pos.	Microfilm	16/35mm	24 FPM
316D35	Neg/Pos.	B&W	16/35mm	32 FPM
316D35M	Neg/Pos.	Microfilm	16/35mm	32 FPM
416D35	Neg/Pos.	B&W	16/35mm	80 FPM
PN100	Neg/Pos.	B&W	16/35mm	100 FPM
S 150-R	Neg/Pos.	B&W	16/35mm	150 FPM
470 ND	Neg/Pos.	B&W	70mm	10 FPM
35ND70	Neg/Pos.	B&W	35/70mm	30 FPM
70R10	Reversal	B&W	70mm	10 FPM
R 15	Rev & Neg/Pos.	B&W	16mm	15 FPM
R15TC	Rev & Neg/Pos.	B&W	16mm	15 FPM
R40	Rev & Neg/Pos.	B&W	16mm	25 FPM
R40TC	Rev & Neg/Pos.	B&W	16mm	25 FPM
RT-S	Rev & Neg/Pos.	B&W	16mm	85-125 FPM
R-60	Rev & Neg/Pos.	B&W	16mm	30 FPM
R-17-35	Rev & Neg/Pos.	B&W	16/35mm	17 FPM
R-60S	Rev & Neg/Pos.	B&W	16mm	60 FPM
R-90	Rev & Neg/Pos.	B&W	16mm	90 FPM
CN-10	Eastman Neg Ektacolor	Color	46mm	12 FPM
CN35-10	Eastman Neg Ektacolor	Color	35/46mm	12 FPM
ENP-25	Eastman Neg	Color	16/35mm	25 FPM
ACE 20	Ansco/Ektachrome 7255 Ektachrome Eastman SO 260 SO 270	Color	16mm	22 FPM
ACE 40	Ansco	Color	16mm	36 FPM
16KC-60	Kodachrome	Color	16mm	60 FPM
35KC-45	Kodachrome	Color	16mm 35mm	45 FPM 8 FPM

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Three photographic scientists in the Kodak Research Laboratories have been named Senior Research Associate, a title reserved for those who have made significant contributions over a period of years to the work of the laboratories. They are: John Spence, Nicholas H. Groet and Forrest Richey. Dr. Spence has been with the Laboratories for 25 years and has made noteworthy contributions in the field of optical sensitizing of photographic emulsions. Mr. Groet has been with the Laboratories since 1934 and is considered an authority on color films. Mr. Richey has been with the color photography division of the Laboratories since 1944. His work has been concerned mainly with the development of various types of color films and he has also worked on the development of processing methods.

Major General J. B. Medaris was elected Chairman of the Board of Electronic Teaching Laboratories, Washington, D.C., following his retirement from the Army, January 1, 1960, after 37 years of service. Maj. Gen. Medaris, who commanded the Army Ordnance Missile Command and directed missile and space programs, was guest speaker at the Society's Convention at Miami Beach, May 4, 1959. His address on "The SMPTE, The Army, Missiles and Space Vehicles" appears in the July 1959 *Journal* (pp. 490–491).

J. R. Johnstone has been appointed administrative assistant in the office of William H. Feathers, President, National Carbon Co., Division of Union Carbide Corp. He was formerly marketing manager of carbon products.

New assignments within the marketing organization of National Carbon Co., division of Union Carbide Corp., include Curry E. Ford, Director of Marketing; James King, Jr., Manager, Electrode Products; A. W. Wolff, Manager, Industrial Carbon Products; W. C. McCosh, Manager, Carbon Products; and W. G. Pitt, Manager, New Product Market Development.

Eric J. Sheldon has been appointed Director of National Sales for Standard Camera Corp., 319 Fifth Ave., New York. Prior to his present appointment he was Sales Manager of the Eastern Division, Technicolor Products, Inc. He has also held managerial posts in Kling Photo Corp., and O.W. Ray Corp., where he was a vice-president.

Cecil S. Bidlack of Smith Electronics, Inc., has joined the firm of Carl E. Smith Consulting Radio Engineers, Brecksville, Ohio. Mr. Bidlack was formerly with the National Association of Educational Broadcasters. In his present post he will be engaged in consulting work in television and FM broadcast.

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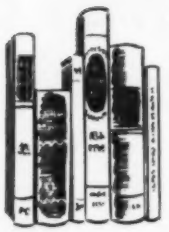

books reviewed

Sound in the Theatre

By Harold Burris-Meyer and Vincent Mallory. Published (1959) by Radio Magazines, Inc., P. O. Box 629, Mineola, N.Y. 95 pp. incl. index, illus. and diagrams. 10¼ by 8¼ in. Price $10.00.

Sound in the Theatre is an exposition for the benefit of those who plan, supply and utilize electronic equipment for public address, sound reinforcement, or for specialized theatrical purposes. Several chapters are devoted to an elementary discussion of the characteristics of sound, hearing and architectural acoustics. Sound sources and means for microphone pickup are described. Some aspects of typical sound systems are considered: the combination of amplifiers, mixers, volume indicators and monitoring facilities which may be required. While one can use such information as a guide, problems of distortion, signal to noise, grounding and shielding are left to the experience of the user. No discussion is given pertaining to the various forms of electrical equalization which may be employed to simulate various sound effects.

The use of set-up sheets or an adaptation of musical scoring is demonstrated as a useful means of controlling complicated sound effects accompanying drama. These have been used by the reviewer in the past to score battle noise sound sequences and are quite effective.

This book should prove to be useful for those interested in the use of sound to augment drama; and it has at least sufficient information, to cause those interested to seek additional technical detail in the literature.—*F. L. Hopper*, Bell Telephone Laboratories, Inc., 3300 Lexington Rd., S.E., Winston-Salem, N.C.

Cinefluorography

Edited by: George H. S. Ramsey, M.D., James S. Watson, Jr., M.D., Theodore A. Tristan, M.D., Sydney Weinberg and William S. Cornwell, M.A. Published (1959) by Charles C. Thomas, 301–327 E. Lawrence Ave., Springfield, Ill. x-xvi + 266 pp. incl. contents, illus. and diagrams. 7 by 10-in. Price $11.75.

Drs. George H. Ramsey and James S. Watson, Jr., should be congratulated on organizing the first Symposium on Cinefluorography in this country. There was a great need for the exchange of ideas and experience among various workers engaged in this field, and this Symposium

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proved to be an excellent solution of the problem.

The proceedings of the meeting held in Rochester are very well presented in this monograph. The test is clear and the illustrations are informative. The contents cover the entire field of x-ray motion pictures starting with the historical review of the subject, and ending with the latest technical development in image amplifiers. There are some omissions in the historical outline of the development of cinefluorography. In particular the patent literature is not described at all and the earliest patents for x-ray image amplifiers such as Langmuir, U.S. Patent No. 2,198,479, and Sheldon, U.S. Patent No. 2,555,423, are not mentioned.

The problems of making x-ray motion pictures are analyzed in many aspects in separate chapters. The x-ray image amplifiers, without which it was impossible to produce adequate x-ray motion pictures of humans, are well described in chapters by A. Lignon, J. Feddema, J. Jacobs and B. Kazan.

The optical and photographic equipment necessary for cinefluorography are well discussed by G. Chambers, F. Dreisinger, R. Kingslake, F. O'Brien, G. Corney and Dr. J. Watson and S. Weinberg. The very important problem of the x-ray dose received by the patient in making the x-ray motion picture is well analyzed by Dr. T. Tristan. The medical diagnostic value of the x-ray motion picture is treated rather shortly; as Dr. F. Campeti explains it, this branch of radiology has not as yet been developed as it should be. Only 3% of published papers on cinefluorography deal with diagnostic analysis of x-ray motion pictures.

In conclusion this books fills an important gap in radiological literature. We hope that the second Symposium on Cinefluorography will be published in the near future.—*E. E. Sheldon, M. D.*, Radiologist, 30 E. 40 St., Professional Medical Bldg., New York 16.

The Sixth Edition of the Audio-Visual Equipment Directory has been brought up to date with illustrations and descriptions of new equipment and contains two new illustrated sections, Language Laboratory Systems and Transparency-Making Equipment. The latter section describes 36 different pieces of equipment used to produce transparencies for overhead projectors. The volume contains 250 pages, is 8½ by 11-in., plastic-bound. Editor is James W. Hulfish, Jr. It is available from National Audio-Visual Association, Fairfax, Va., at a price of $4.25 if payment accompanies order, otherwise, $4.75.

Career: For the Experienced Engineer and Scientist is published by Careers, Inc., 15 W. 45 St., New York 36. The Winter 1960 edition is available at a price of $1.95. The publication is distributed without charge to alumni of ECPD-accredited colleges and universities through alumni placement offices or other accredited agencies. The volume gives a rundown of job information contributed by officials of the main companies employing engineers and scientists.

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section reports

The Atlanta Section met on February 16 at Bradley Observatory, Agnes Scott College, Decatur, Ga., with an attendance of 31. Dr. William Calder of the Agnes Scott College addressed the group. His subject was Radio Astronomy.

Dr. Calder presented slides showing pictures taken with optical telescopes of some of the known sources of the radio waves that permit the relatively new field of radio astronomy. These waves are hydrogen emission with a frequency of 1420 mc. In addition, pictures were shown of existing radio telescopes and an engineer's rendering of the 600′ telescope being built by the United States in West Virginia. This telescope will be twice as large as any existing radio telescope and will be a considerable step forward both in range and definition.

While these radio telescopes may or may not be able to answer the question as to whether the universe is continuously expanding, they give strong support that it is. So far a Doppler shift has been observed that agrees with the shift that has been observed optically. The range of the 600′ telescope will give information as to whether this Doppler shift is observable at much greater distances than is now possible to observe even with the 200″ optical telescope.

After the meeting the members were allowed to inspect the college's optical telescope. Unfortunately, the evening was overcast and it was not possible to do any star gazing. Dr. Calder also demonstrated a small planetarium that he had built and invited all members of the Section to attend meetings of his astronomy club, which meets at 8 p.m. on the third Friday of each month.

The new appointive officers, Bob Holbrook, Program Chairman, and Durward Thayer, Membership Chairman, were announced at the meeting.—Wesley R. Sandell, *Secretary-Treasurer*, c/o Kodak Processing Laboratory, 4729 Miller Dr., Chamblee, Ga.

The Dallas-Fort Worth Section met on February 18 at the Beard and Stone Auditorium in Dallas with an attendance of 55. Guest speakers were Gordon Tubbs of Eastman Kodak Co., who discussed "Eastman Kodak Ektachrome E. R. Film" and Bruce Jamieson of Jamieson Film Co., whose subject was "Processing of Kodak Ektachrome E. R. Film."

Mr. Tubbs' discussion included some history of the development of Ektachrome E. R. Film and covered the general properties of this new emulsion. He screened original reversals, prints made from these originals and shots made under various lighting conditions, including exposures at 3000 frames/min.

Mr. Jamieson talked about his experiences in processing Ektachrome E. R. Film and the development of a procedure to be used with their high efficiency tube type

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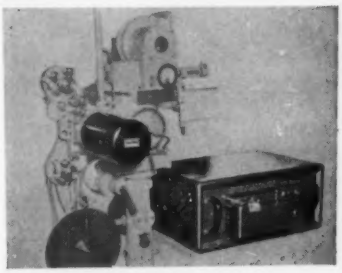

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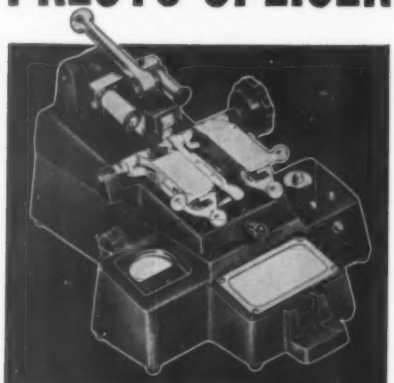

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machine, which he discussed before our Section last July. He then screened some test films that his company has shot for experimental uses in developing a processing procedure. These scenes ranged from illumination levels of a match used by the subject, to exteriors shot at f/16 with a 45° shutter.

At the close of the meeting, the group visited the nearby studios of Jamieson Film Co., where we inspected their facilities for processing this film. Coffee and cookies were served at the studio.—Malcolm D. McCarty, *Secretary-Treasurer*, 4401 Wildwood Rd., Dallas, Texas.

The Hollywood Section met on February 16 at NBC Studio E with an attendance of 300. Speakers were Robert Gunther, Aerojet General Corp., who discussed "Infra-Red"; Jay E. Gordon, North American Aviation, whose subject was "Nautilus Arctic Passage"; Bill Gibson, Douglas Aircraft Co., who talked about "The Big Reach"; and Betty Williams, Lockheed Aircraft Corp., who discussed "The Big Stick."

The general theme of the program was "The Role of Motion Pictures in Industry as a Communications Tool." The program was presented by the Industry Film Producers Association, whose president Mr. Gunther described briefly the aims and purposes of the Association. The IFPA Secretary, Jack R. Smith of Thompson-Ramo-Wooldridge, introduced each of the above-mentioned speakers who gave supplementary information about their films. —Ralph E. Lovell, *Secretary-Treasurer*, 2554 Prosser Ave., Los Angeles 64, Calif.

The New York Section met on February 10 at the World Affairs Center Auditorium with an attendance of 132. Guest speaker Anthony H. Lind, Radio Corp. of America, discussed "Fundamentals of Video-Tape Recording Machine Design and a Status Report of their Operation."

Mr. Lind presented a concise discourse on the fundamentals of video-tape machine design, illustrating his talk with slides showing the key areas of control and principles of operation. After the coffee break, the meeting reconvened for a question-and-answer period covering the current scope of video-tape use, and probable growth.—James W. Kaylor, *Secretary-Treasurer*, c/o Movielab Film Laboratories, Inc., 619 West 54 St., New York 19.

The Rochester Section met on February 18 at the Dept. of Radiology, Strong Memorial Hospital, Univ. of Rochester, with an attendance of 72. Sidney Weinberg discussed cinefluorography at the meeting. Mr. Weinberg is an associate in cinefluorography, Dept. of Radiology, Rochester School of Medicine and Dentistry.

Mr. Weinberg demonstrated his projector adaptation which allows for still framing, reverse projection and forward speed at various film rates. The demonstration was done with scenes showing athletes in action.

After demonstrating the projector, he showed movies made through the technique of cinefluorography. Following this showing, the group toured the facilities of the Cinefluorography Dept. Much of the equipment used there has been designed by Mr. Weinberg and members of his group.

This second meeting of the 1960 season proved to be very interesting. A discussion period of about an hour followed the demonstrations of X-ray motion pictures that were shown after the formal presentation.—Wilbur G. Hill, *Secretary-Treasurer*, 10 Hillcrest Ave., Binghamton, N.Y.

The San Francisco Section's members preceded their February 9 meeting with cocktails and dinner at the Rathskeller Restaurant, afterwards gathering at the KGO-TV Studios, with 54 attending, to hear two guest speakers from Los Angeles.

Ralph Sogge, of Magnasync Mfg. Co., Los Angeles, spoke first, on "Equipping Modern Motion-Picture Sound Recording Studios." He described the equipment made by Magnasync as being designed around a high quality film transport. Using this transport system as a heart and adding elements as needed the Magnasync system may be expanded from a basic fundamental recorder to any degree of complexity, according to the requirements of the user. A question and answer period followed.

The second speaker of the evening was D. J. White, President of Magnasync. Mr. White presented "The Nomad," a completely self-contained portable and versatile sound system with professional lip-sync sound, designed for the serious amateur.

Magnasync equipment was available for inspection after the meeting.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco 24.

A social evening started an exciting year for the **Washington, D. C., Section.** One hundred and fifty members and guests met February 17 at the Motion Picture Association of America's Academia for an evening of entertainment and refreshments.

Howland Pike, the new chairman, welcomed the members and guests. He described the aims of the Society so that our guests could better understand our function. Speaking further, Mr. Pike reminded the membership to remember the "other fellow" when programs were being planned.

John L. "Scott" Robertson, Jr., (Board of Managers), was introduced as the Program Chairman.

Mr. Robertson outlined the possible programs for which the Washington, D.C., Section has tentative arrangements. The membership was asked what programs they would support with their own attendance and would encourage them to invite guests. The attending members indicated a preference for two papers on one program and both papers to be on one or a closely related subject with plenty of time for discussion.

It was later decided to poll the entire membership via a letter to ascertain their desires on programming for 1960. Because of this, no results of the poll taken during the meeting are being made public at this time.

The program committee was greatly encouraged by the enthusiastic acceptance of the majority of the proposals—certainly enough to guarantee a memorable year with some left over for 1961!—William E. Youngs, *Secretary-Treasurer*, 235 E. Greenway Blvd., Falls Church, Va.

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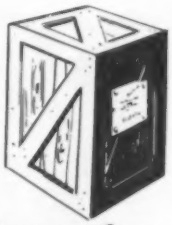

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Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

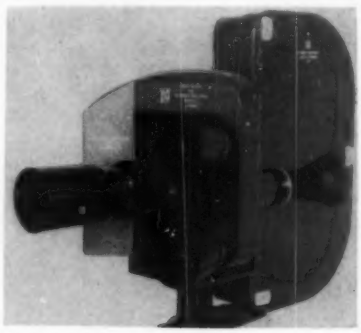
A four-day Workshop Seminar in Animation Film Techniques, sponsored by Florman & Babb, Inc., New York, and Warren C. Portman Co., Mt. Vernon, N.Y., is scheduled for June 12 through 15. It will be held in the New York Trade Show Building, 500 Eighth Ave., New York 1. Specially priced accommodations for participants will be available at the Hotel New Yorker, across the street. The Seminar is free to anyone in the motion-picture industry, but early registration is urged by the sponsors as attendance is limited to 100. A complete program and a registration form may be obtained by writing Charles Lipow, Florman & Babb, Inc., 68 W. 45 St., New York 36. Eight sessions will be held during the four days and will be conducted by Warren Portman, Charles Lipow and Arthur Florman. The first session will present a general outline of animation covering basic principles and terminology. Other topics of discussion will be multiple effects units, such as ripple glasses; and use of double ring compound, automatic focusing, live action zooms, and squeeze- and slide-motion techniques.

Among those from the animation field who will participate is Ernest M. Pittaro, production supervisor for TV films for Dancer-Fitzgerald-Sample, Inc., and author of *TV and Film Production Data Book*.

Pay-TV is in the news again following the successful unveiling of Telemeter toll-TV February 26 in Toronto, Can., installed by Trans Canada Telemeter, a division of Famous Players Canadian Corp., Ltd., West Toronto. ("Smash Hit" said the *New York Herald Tribune*.) About 1000 Canadian dollars dropped in the coin meters as *Journey to the Center of the Earth* came over the closed-circuit system, which has been set up to accommodate 13,000 subscribers.

The Canadian experiment seems to have revitalized the ghost of Pay-TV in the United States, somewhat laid to rest by stringent FCC restrictions. Last development of any real note was the Bartlesville, Okla., experiment (*Jour.*, 635–638, Oct. 1957). After that little was heard of Pay-TV, although a few companies continued to develop equipment and, from time to time, hold up a finger to the wind. Jerrold Electronics Corp., of Philadelphia, which supplied equipment for the Bartlesville test, worked with Telemeter on the Canadian experiment.

Experimental Pay-TV systems fall mainly into one of two categories — closed-circuit and broadcast. Five of the main companies interested in Pay-TV, and the methods presently favored are: Blonder-Tongue Labs., "BiTran" system to substitute pay program for regular TV program by means of a telephone line key when so desired by the subscriber; International Telemeter Corp., a subsidiary of Paramount Pictures, Inc., coin-box mechanism to unscramble coded picture; Skiatron, punch card for decoding; TeleGlobe, clear video with audio over telephone lines; Zenith, decoding signal sent over the air to unscramble over-the-air programs.



The 35mm Newman Sinclair Kine Camera, Model P/400, is a portable electric camera designed to be as small and as light in weight as possible. It is a product of James A. Sinclair & Co. Ltd., 3 Whitehall, London, S.W.1. It weighs only 6¼ lb, including tachometer. Dimensions are 7 by 7 by 9 in. The motor drive unit is built into the camera for battery or line current. A synchronous motor is available for outside attachment. The film gate is register pin clamping type and enables the film to be run in reverse if desired. The firm's friction-type gate is available if required. The turret front is strongly constructed and will accommodate a wide range of lenses from 18 mm to 60 in. and also zoom-type lenses.

The Nuvistor miniature electron tube (*Jour.*, p. 358, May 1959) will soon be in production, it was announced by Radio Corp. of America. TV receivers, cameras, and computing devices employing the thimble-size tube are now being built on an experimental basis.

Leasing of motion-picture equipments ranging from animation and special effects stands through zoom and telephoto lenses can be arranged under a new plan offered by S.O.S. Cinema Supply Corp., 602 W. 52 St., New York 19. The plan is said to have certain advantages over previous rental systems. An 8-page booklet, available from the firm, describes in detail the plan which, in effect, can be used as financing arrangement for major equipment.

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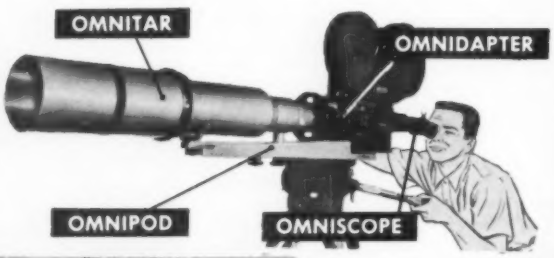

A range of fast television lenses for I-O TV cameras with RCA mounts is available in 125mm, 150mm, 200mm, 400mm and 600mm lengths. Speeds F2.8 to F5

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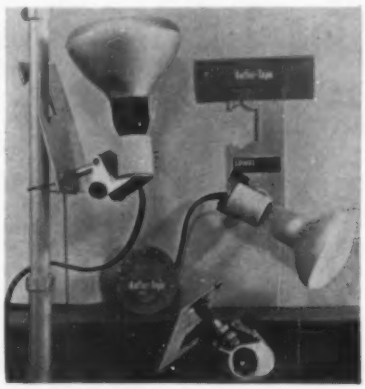
A 4½-in. image orthicon, the RCA-7389-A, has been announced by the Electron Tube Div., Radio Corp. of America, Harrison, N.J. It has been designed to provide superior black-and-white TV pictures within the framework of existing standards. The new tube is unilaterally interchangeable with the 7389. Despite the increased size of its image section, the 7389-A uses the same optics and the same optical-image size required for 3-in. tubes.

New target material has been employed by the Electron Tube Division of Westinghouse Electric Corp., Box 2278, Pittsburgh 30, in the development of an image orthicon with increased life expectancy. The new tube is said to be virtually immune to image retention and is warranted by the firm for a minimum life of 1000 hr. It is now in production at a suggested price of $1470.00.



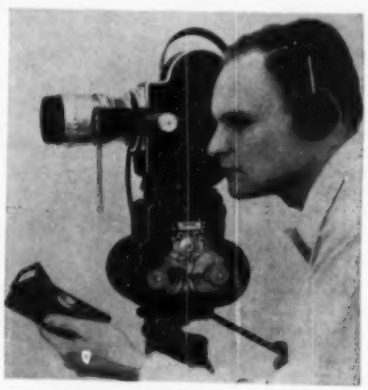
The Lowel-Light, a compact lighting unit that can be taped directly to walls, windows and flat surfaces with a special Gaffer-Tape is a product of Lowel-Light Photo Engineering, 421 W. 54 St., New York 19. A notch and chain device is used to lock the unit on stands, pipes, furniture, doors, etc. A swivel design, with heat-insulated finger grips provides directional control. The price of $6.95 a unit includes a supply of the special tape.

A building block switching system designed to permit simultaneous multiple circuit switching, with a reduced investment in switching equipment has been announced by Telecontrol Corp., 1418 W. 166 St., Gardena, Calif. Key to the system s a remotely controlled multiple-circuit rotary stepping switch. Switching is accomplished within a one-inch radius, designed for video switching with extremely low capacitance. Three basic systems incorporating the switching design are presently available: program switching systems, distribution switching systems and special-effects input switching systems. The systems can be custom-assembled to any station's individual requirements.

A close-up adapter for the Super Universal Zoomar Lens produced by the Television Zoomar Co., 500 Fifth Ave., New York 36, is designed especially for television tape and live commercials. Another newly announced converter for the lens has a range of 12 in. through 72 in. and is used for news photography and sports events.

A versatile new zoom lens with a wide focal range (2 in. through 40 in.) has been announced by Taylor, Taylor & Hobson of Leicester, a Division of Rank Precision Industries Ltd. Designed specifically for television cameras, the lens is expected to have useful application to color television. Sole agent in the United States for this and other Taylor, Taylor & Hobson products is Albion Optical Co., 1410 N. Van Ness Ave., Los Angeles 28.

A lamp for television studios, designed for flexibility and versatility, has been announced by Mole-Richardson of England (a branch of Mole-Richardson, 941 N. Sycamore Ave., Hollywood 38.) The housing of the lamp, which has been named the Dualite, is a strong sphere made of glass fiber. It will accommodate either a 1-kw or a 2-kw bipost bulb. The 12-in. Fresnel lens can be interchanged with a diffuser so that the lamp can be used either as a spot or a flood. Optional accessories include devices for controlling tilt, pan, focus, switching and barndoor setting by means of a pole from the floor. The lamp weighs 29 lb. It was first installed at the ABC Studio, Teddington, England. The firm has also announced a new microphone boom that can swing through a 360° angle. It is built with a circular platform to enable the operator to move freely with it.



The Magnasync Nomad, a product of Magnasync Corp., 5546 Satsuma Ave., North Hollywood, is a portable (7-lb) recorder-reproducer sound system that can be attached to any camera or projector. The camera and recorder-reproducer are interlocked through a flexible cable with the camera driving the recorder. The record-play amplifier is transistorized with self-contained rechargeable batteries. For lengthy sequences a d-c motor can be attached to drive both recorder and camera through a flexible cable. The recorder uses split 16mm magnetic film and has a twin-track record head and playback head wide enough to scan both tracks. The unit includes a hand mixer which contains a VU meter, record and playback controls, film-direct monitor switch, battery test provision, microphone input and earphone output jack. For playback, the recorder-reproducer and projector are interlocked through a flexible cable. When a magnetic projector is used, a 1 : 1 transfer from recorder to a magnetically striped film can be made while both units are tack-shaft interlocked. The unit is priced at $585.00.

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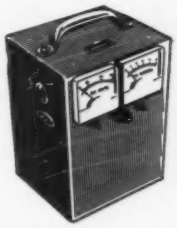

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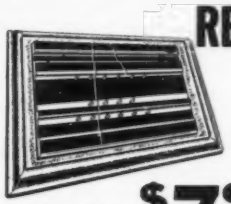

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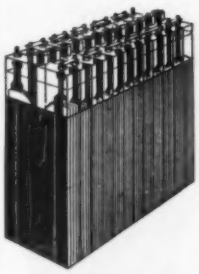

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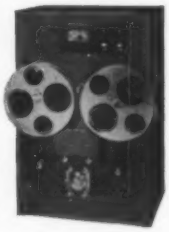

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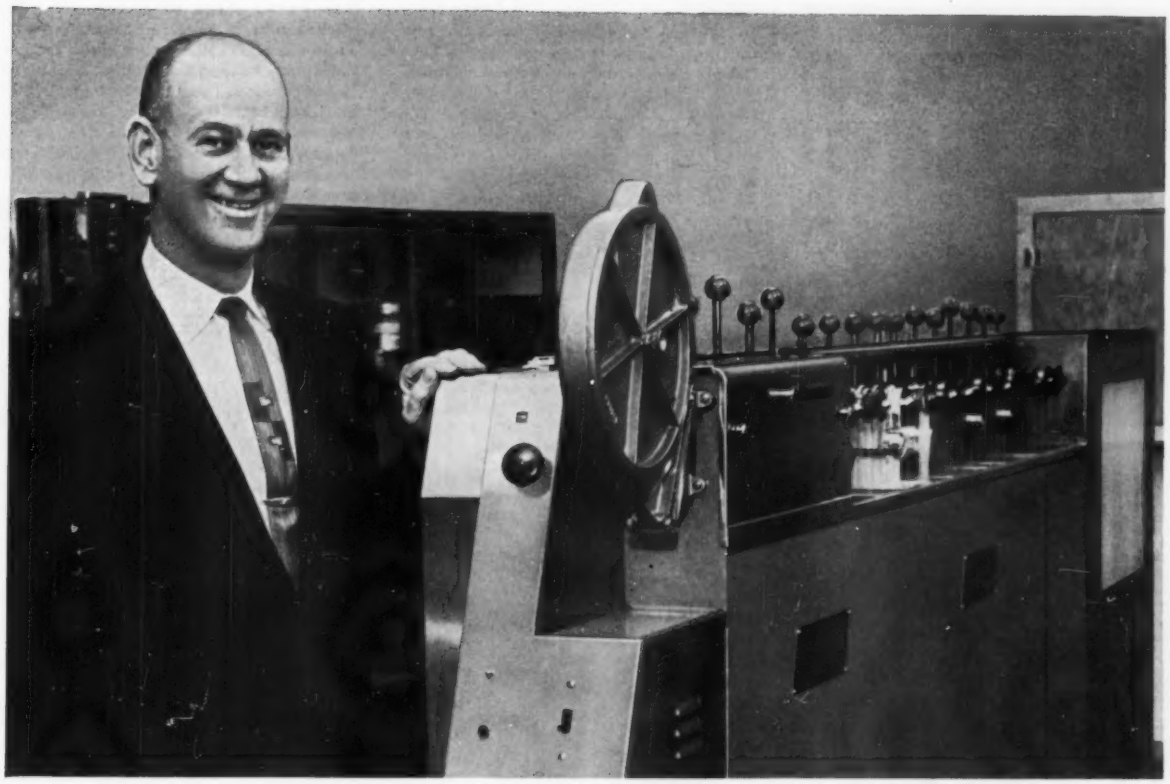
See Cinemiracle (Los Angeles, Chicago, New York, London, Oslo. Munich) — 20th Century-Fox, Convair, RCA Photophone, Africana TV, Helsinki U., Crawley Films (Canada) and many others specify S-H equipment.

The Camex Reflex 8, a single-lens reflex camera featuring continuous through-the-lens viewing and focusing while filming is described in detail in a folder available from Karl Heitz, Inc., 480 Lexington Ave., New York 17. The camera can be used with interchangeable lenses from 6.25mm up to 145mm super-telephoto (12× magnification) and with close-up attachments focusing down to one inch. The camera can also be used for microcinematography, macrocinematography and endoscopic cinematography when adapted with suitable attachments. The camera is equipped with a warning signal which indicates the beginning and the end of a usable 25-ft film run. A black zone on the footage counter indicates the unusable part of the film. Coupled to it is a black marker which appears in the lower half of the reflex image. It remains visible during the run of the film leader, then disappears automatically and appears again at the end of the usable film run. Prices range from $179.00 through $359.00, depending on type of lens and attachments. A charge of $20.00 is added for synchronization for electric flash.

A solid state transistorized power supply has been developed by Autotronics Inc., Dept. 23, Box 208, Florissant, Mo., for use in its own laboratory, with commercial production being considered. Dimensions are 5 by 5 by 6 in. Electrical specifications include: input voltage, 95-v to 135-v a-c, rms 60-c single-phase; output voltage range, 0–50-v a-c, continuously variable; output current, 0 to ½-amp d-c; regulation, 0.02% no load to full load; drift, after initial stabilization period of 15 sec, output voltage does not change more than 0.07 v about chosen setting; line regulation, 0.01% for a 35-v rms change in input voltage, the output voltage changes 0.002-v d-c.

A solid-state power supply, Model PS1, designed to operate from input voltage of 85-v to 250-v a-c, 50/60 c, has been announced by Stancil-Hoffman Corp., 921 N. Highland Ave., Hollywood 38. The unit supplies a regulated 117-v 400-c a-c and 28-v d-c held to ± 2% from no load to full load. Height of the unit is 21 in. and weight, about 150 lb. It is priced at $2700.

Additions to the line of TapeStrobes, devices for measuring the speed of magnetic tape, have been announced by Scott Instrument Labs., Inc., 17 E. 48 St., New York 17. In addition to its standard 7½, 15, 30 ips Model A, the firm now offers a standard 3¾, 7½, 15 ips Model B. A special step-down adapter (Model W) adds the additional speed of 3¾ ips toModel A and 1⅞ ips to Model B.



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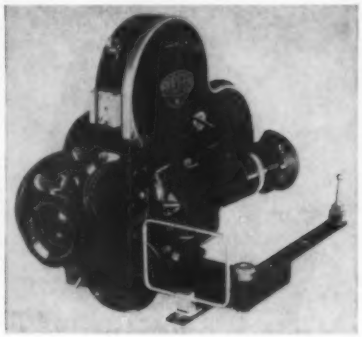
An anamorphic lens designed to convert any 16mm projector for the showing of CinemaScope wide-screen motion pictures has been announced by Victor Animatograph Corp., Division of the Kalart Co., Plainville, Conn. The lens, called the Victorscope, is also designed for use as a supplementary camera lens for photographing in CinemaScope by means of a special adapter. The lens is attached to the projector by brackets. It is priced at $169.00.

Portable hot splicers, formerly distributed by Bell & Howell Co. as Models 198A and 198B, are now exclusively distributed by Traid Corp., 17136 Ventura Blvd., Encino, Calif. The splicers are now designated Model 116 for 16mm and 8mm film and Model 135 for 35mm and 16mm. The splicers feature a built-in automatic scraper assembly.

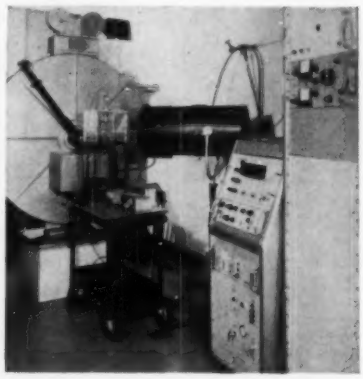


A dual-purpose, open-frame tracking finder for chase-plane use and sports reporting, designed for use with Arriflex cameras, has been announced by Birns & Sawyer Cine Equipment Co., 6424 Santa Monica Blvd., Hollywood 38. The device is a lightweight target sight adjustable for both 25mm and 50mm lenses. The assembly mounts to the camera by means of a pistol grip or other tripod stud. Both front frame outline and rear target sight collapse on a spring-loaded mount when not in use. It is priced at $49.50.

A magnetic reproduce unit for Kodak Pageant Sound Projectors has been announced by Greg, Box 11, Eastside Station, Binghamton, N.Y. Described as a conversion unit to adapt optical sound projectors to reproduce magnetic soundtracks on 16mm film, it is designed for ready installation on the projector. The magnetic head scans at the standard point at 28 frames ahead of the picture. It has an impedance of 100 ohms, an inductance of 12 mh, and a gap of 0.0005 in.

A flexible 8mm projector system consisting of the Agfa Sonector-8 projector used with either of two attachments has been announced by Agfa, Inc., 516 W. 34 St., New York 1, N.Y. One attachment is called the Sonector-Phon and is used for playback from a magnetic soundtrack on the film, the other, the Synchronovox is used to synchronize sound with action in the motion picture. The projector with the sound-on-film attachment is priced at $299.00. The synchronizing attachment, sold separately, is priced at $58.00.

The Pantel series of professional telephoto lenses, manufactured exclusively for Traid Corp., 17136 Ventura Blvd., Encino, Calif., may be used with 16mm, 35mm and 70mm cameras. Focal lengths range from 4 in. through 24 in. Optical surfaces are coated with magnesium fluoride antireflection coating on metal surfaces are anodized. The lenses are equipped with precision mounts for a number of cameras with mounts for others available on special order. Prices range from $139.00 through $595.00.

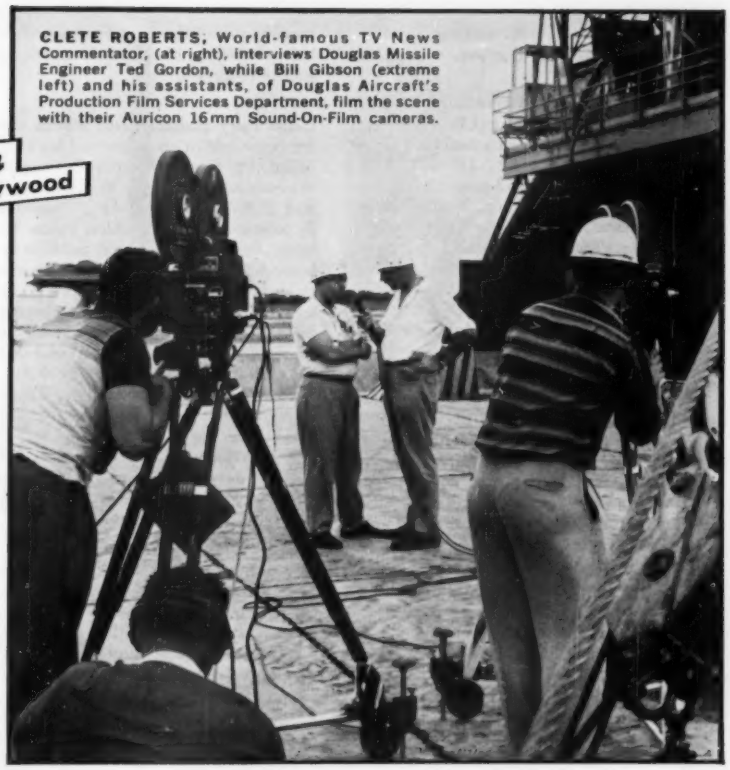


A stationary-film camera capable of a speed of more than 1½ million frames/sec is manufactured by the Benson-Lehner Corp., 1860 Franklin St., Santa Monica, Calif. Developed by Albert T. Ellis (*Jour.* p. 360, May 1959), the camera is known as the Ellis Ultra Speed Camera. Its speed is such that an event of one-second duration photographed by this camera would if projected at the standard projection rate of 16 frames/sec, seemingly have a duration of 28 hours. This speed makes possible many advanced scientific and industrial studies of such phenomena as explosions, combustion, vibration, impact, fatigue in metals, and events otherwise invisible.

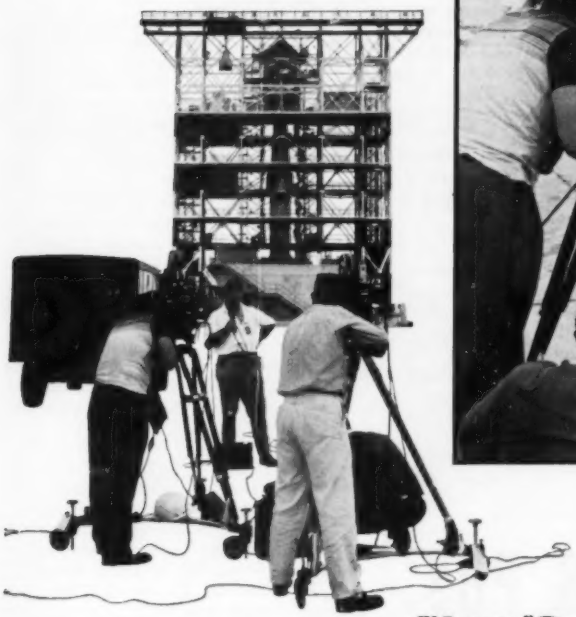
The complete camera system consists of four units: camera, camera-control unit, light-control unit and flashlamp. The lighting is provided by a General Electric Type FT 623 flashlamp. The camera has a film box shaped like a large disc with feed and take-up magazines placed at the top. The objective and shutter assemblies are situated at the front end of the disc's center axis, and a high-speed air turbine and a revolving mirror are located at the rear end. A radial focusing periscope is attached immediately behind the tubular lens assembly. The Kerr cell shutter unit consists of two polarizing filters, one on either side of a 1¼-in.-diameter cell containing nitrobenzene and two nickel electrodes which produce a controlled electric field. The 1¼-in. Kerr cell produces an effective shutter aperture of ¼-in. When light rays pass through the Kerr cell shutter, two optical lenses transmit the image to a rotating mirror in the film box. The 35mm film lies, with emulsion side inwards, at the periphery of the circular film box. The rotating mirror is a wedge-shaped piece of nickel-plated aluminum attached to the shaft of a 100,000-rpm variable speed, compressed air turbine. Mounted at the center of the circle, with its face at a 45° angle to the axis of rotation, the mirror directs the

DOUGLAS

Auricon Hollywood



CLETE ROBERTS, World-famous TV News Commentator, (at right), interviews Douglas Missile Engineer Ted Gordon, while Bill Gibson (extreme left) and his assistants, of Douglas Aircraft's Production Film Services Department, film the scene with their Auricon 16mm Sound-On-Film cameras.



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AURICON SUPER-1200 SOUND-CAMERA FEATURES:

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- ★ 1200 ft. film capacity for 33 minutes of continuous recording.
- ★ Optional Optical or Filmagnetic Sound-On-Film.
- ★ ... and many other features!

During the critical count-down and through the thunderous and fiery launchings of the Air Force Thor Missile at Cape Canaveral, every detail of these space technology achievements is faithfully recorded with sound and color film. Auricon 16mm Cameras, operate by remote control within 200 feet of the searing blast of the rocket engines!

The reliability of Auricon Sound Cameras is a vital factor in providing Air Force officials and Douglas Top Management with "Quick-Look" Progress Reports of the very successful missile firings of the Thor IRBM. In less than 72 hours from "zero-time" at Cape Canaveral, Florida, the Filmed Progress Report is flown to California, processed, edited, titled, and made available for viewing and technical evaluation. Auricon missile-launching sound films are produced for as little as $200 per film ... a tiny price for fast, comprehensive, and truly graphic reporting!

Auricon 16mm "Talking Pictures" may be ideal in your business, for technical reporting and sales promotion. Write us about your motion picture sound recording requirements.

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100 ft. Runs 2¾ min.	600 ft. Runs 16½ min.	1200 ft. Runs 33 min.
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light rays to the stationary film and, as it revolves, carries the image along the circular periphery of the film box.

The 8-ton ROTI (Recording Optical Tracking Instrument) (George Economou et al., "Automatic-exposure control for a high-resolution camera," *Jour.*, 249–251, Apr. 1958) is described in a 12-page illustrated brochure available from Perkin-Elmer Corp., Norwalk, Conn. The brochure describes operational features and specifications and illustrates the resolution obtainable with the system. A mobile missile tracking system known as TPR (Telescopic Photographic Recorder) is also described.

Schneider Lenses is a 26-page illustrated catalog containing descriptions and specifications of various types of Schneider lenses and other equipment available from Burleigh Brooks Inc., 420 Grand Ave., Englewood, N.J. It is priced at 25 cents. General purpose lenses described in the catalog include Xenar Xenotar, and Symman. Wide-angle lenses include the Angulon and Super-Angulon. Telephoto lenses include the Tele-Xenar and Tele-Arton.

A new department, Photographic and Industrial Optics Sales, has been created by Bausch & Lomb Optical Co., Rochester 2, N.Y., to integrate within one department sales of all motion-picture equipment handled by the company: the Balcold reflector, CinemaScope and Cinephor projection lenses, Baltar lenses and specialized lenses and filters. Head of the new department is E. F. Day, formerly head of the company's Photographic and Special Products section.

Laboratory facilities and studio services are described in an illustrated booklet published by Byron Motion Pictures, 1226 Wisconsin Ave. N.W., Washington, D.C., and 1220 E. Colonial Dr., Orlando, Fla. In announcing the booklet, Byron Roudabush, President, said that publication had been delayed five years to include descriptions of new developments and additional services, such as Arri color developing and printing process (Robert E. Johnson, "First U.S. installation of Arri color developing equipment," *Jour.*, 599–603, Nov. 1956); Westrex sound system (Robert W. Eberenz, "An integrated sound service studio for the 16mm producer," *Jour.*, 332–335, May 1959); and other services such as automation and electronic control system, 35mm facilities and high-speed negative spray processing.

Rewind, a monthly publication of General Film Laboratories, 106 W. 14 St., Kansas City, Mo., presents in its January 1960 issue an article on printing 35mm color. A special feature of this publication is a Flow Chart (two pages in color) of Optional Color Processing Procedures at General Film. The chart is an excerpt from General Film's illustrated brochure, *Color Motion Picture Services*, available from the company upon request.

Recording Products, High Power and Nucleonics Department: This is a new department created for the development of advanced types of recording devices for the broadcast industry, for business office data processing and other applications by Radio Corp. of America. Head of the new department is M. A. Trainer.

A plant designed specifically for Teflon — its machining, fabrication and application is described in *Plastips* published by Tri-Point Plastics, Inc., 175 I.U. Willets Rd., Albertson, L.I., N.Y. The leaflet offers information on industrial plastics. The February 1960 issue describes the step-by-step machining of components made of Teflon, a du Pont product. The firm is presently engaged in molding this plastic for engineering and research applications.

A Navy contract for an undisclosed number of photograhic tracking systems to be used at the Pacific Missile Range has been awarded Gordon Enterprises, North Hollywood, Calif. The units, now under construction, will weigh approximately one ton. Designed for precision and mobility, each will support four high-speed tracking cameras with focal lengths up to 180 in. The operator will be seated on the camera mount and will move with the camera as it tracks the missile.

Protect-a-Print, a film base specifically designed to run through cameras, projectors, or readers for cleaning purposes, a product of Photographic Specialties, of Hollywood, is distributed exclusively by Flight Research, Inc., P.O. Box 1-F, Richmond 1, Va. The product is reported as tested both for cleaning effectiveness and safety, and as having a negligible factor of wear, even on glass aperture plates. It has been designed as a fast-cutting abrasive against relatively soft materials such as dirt and built-up film emulsion, using a special cleaning power which is incorporated in the material and is described as breaking into power much finer than jewelers' rouge when it comes in contact with hard surfaces. This product is supplied in units of individually packaged rolls with prices beginning at $60.00 for a 16mm 500-ft roll.

Ultrasonic cleaning is used by Eastman Kodak Co. to clean the coil assembly of the exposure meter used in the Brownie Starmatic Camera and for other applications where chemical and mechanical cleaning methods cannot be used. Ultrasonic cleaners work by cavitation. Pressure pockets, formed by sound waves traveling at high frequency through the water in the cleaning tank, implode against any solid surface in the water, loosening the dirt. A detergent counteracts the acid chemical washed off the coils and the assemblies are rinsed in another tank. A typical ultrasonic unit consists of a tank filled with solution (usually water), a source of high-frequency electricity, and a transducer. The transducer is a ceramic slab, or a laminated combination of metals in a magnetic field, that vibrates when electricity is passed through it.

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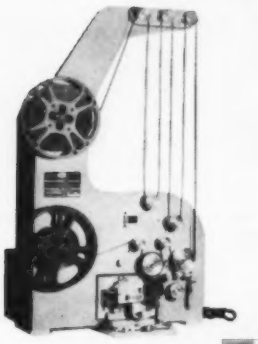
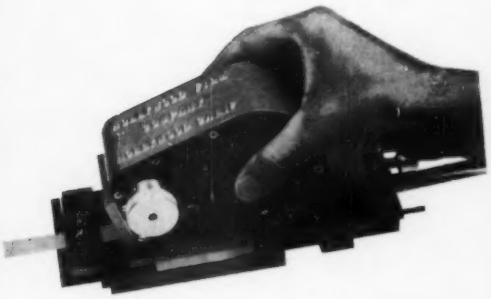
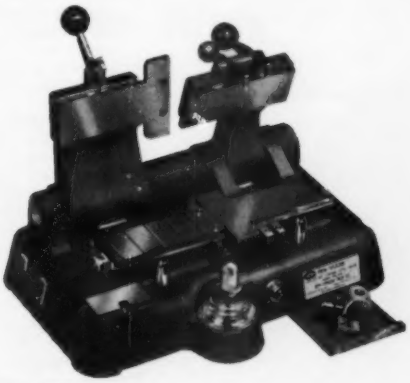


EDGE NUMBERING MACHINES

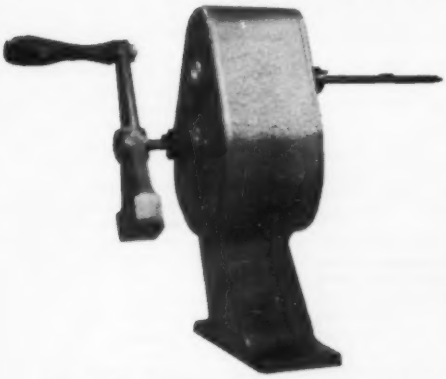
NEGATIVE BREAKDOWN REWIND



AUTOMATIC SPLICERS



HOT SPLICERS



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employment service

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Cameraman Trainee. Young Nigerian wishes to be trained as TV or motion-picture cameraman. Six years local training in Nigeria as projectionist-technician plus 2 yrs work and study in same field with C.M.A. Ltd., London. Practical experience in operation and maintenance of 16 & 35mm films and projectors. Serious student of film since age 15—now 24. Currently employed but anxious to train for a position where ability, sincere interest and creativeness offer opportunity. Will locate anywhere in U.S. Top industry and character references supplied in confidence. Sunny De Iseghohimen, Ministry of Research & Information, Film Production Unit, Ikoyi-Lagos, Nigeria.

Motion-Picture Technician. Just returned from 2 yrs work in Europe and Asia, including installation of motion-picture laboratory in Pakistan for Reevesound, Inc., and production management for Alfred Wagg Pictures. Formerly with Capital Film Laboratories, Washington, D.C., for several yrs; also designed and built production and lab equipment since 1945 under company name of Telex Films. Experienced to do capable work in production, editing, sound and laboratory. Particularly interested in overseas positions, will consider any part of the world. Complete resume on request. Victor E. Patterson, c/o Frank Enge, Jr., 1025 Connecticut Ave., N.W., Washington, D.C.

Motion-Picture Technician, Timer. Age 35, 12 yrs experience in all phases laboratory work, processing supervision, sensitometric control, some knowledge camera work and animation. SMPTE member. Desire permanent position with laboratory or TV station. Complete resume on request. Gunter J. Hackert, c/o Oskar Ernst, 213 East 81 St., New York 28.

Positions Available

Laboratory Processing. Experienced or inexperienced processing man wanted by 16mm lab in Chicago area offering negative, positive, reversal and soundtrack developing. Write P.O. Box 401, West Chicago, Ill.

Motion-Picture Production. Organizers of new corporation in Managua, Nicaragua, require man well versed in professional motion-picture photography, with working knowledge sound recording, color, laboratory work, etc., to prepare budget of equipment necessary to start operating a motion-picture studio on an economical basis. Applicants should preferably be in a position to go to Managua to assist in the installation and operation of the studio, and in the selection and training of technical personnel. Send full information and salary requirements to: Conrad Morgan B., P.O. Box 1926, Managua, Nicaragua.

Cameraman. Prefer man with considerable experience on Mitchell Cameras. Midwest producer with fine reputation and financial standing wants man with ability and experience in lighting sets and operating camera on all kinds of interior and exterior photographic assignments. Very little travel involved in job. Excellent starting salary and opportunity. Write giving full details of past and present employment, equipment used, positions held, etc. Technisonic Studios, Inc., 1201 Brentwood Blvd., St. Louis 17, Mo.

Sales Engineer. Opportunity with West Coast office for sales engineer with manufacturer of theatre lighting and control equipment and architectural incandescent lighting. Work requires ability to call on architects, theatres, consulting electrical engineers, contractors. Location: in and around Los Angeles area. Please forward complete information, which will be kept in strict confidence, to: Century Lighting, Inc., 1840 Berkeley St., Santa Monica, Calif.

Photographer-Editor. Studio in Dallas, Texas, requires qualified motion-picture photographer and editor. Prefer college training. Please furnish references along with resume and salary requirements to: Keitz & Herndon, 3601 Oak Grove, Dallas 4, Texas.

Photographic Equipment Engineer. Excellent opportunity for photo engineer with thorough experience in determining special equipment needs for large photo lab operations, and executing the design specifications thereof. Will act as the authority on systems modifications and additions. Should have knowledge of printing equipment, processing and sensitometry. Write W. F. Marquette, RCA Service Co., Mail Unit 114, Patrick Air Force Base, Florida.

Instrument Design Engineer. To assist with the design of high-speed motion-picture cameras and related products. Degree required in mechanical or electrical engineering with four yrs minimum design experience. A challenging position with a growing company. Write: T. H. Truesdell, D. B. Milliken Co., 131 N. Fifth Ave., Arcadia, Calif.

Television Engineer. GS-855-12, $8810 per yr. To plan, design, coordinate, test and evaluate television equipment for military applications. Position will require about 50% traveling within and possibly outside continental limits of U.S. Applicants must have either 4-yr academic engineering training with bachelor's degree, or equivalent experience or combination of college training and experience; in the latter cases a written test will be required. *Also*, **Sound Recording Equipment Operator Foreman** for TV Division, $4.09 per hr; **TV Video Equipment Operator Foreman** for Television Division, $4.25 per hr. For all positions, Standard Form 57 (Application for Federal Employment), obtainable from the U.S. Civil Service Commission or any Post Office, should be completed and sent to: Civilian Personnel Office, Army Pictorial Center, 35-11 35th Ave., Long Island City 1, N.Y. RA 6-2000, Ext. 238.

Equipment Technicians. To maintain, service, repair all types of mechanical and electronic production equipment. Excellent salary and opportunity to advance with expanding organization. Write fully, all letters kept in strict confidence: Arthur Florman, Florman & Babb, Inc., 68 West 45 St., New York 36.

Equipment Salesmen. To call on industry, government, film producers. Must be willing to travel. Excellent salary and opportunity to advance with expanding organization. Write fully, all letters kept in strict confidence: Arthur Florman, Florman & Babb, Inc., 68 West 45 St., New York 36.

Optical-Photographic Engineers. Excellent opportunities for optical and photographic engineers with or without experience in optical instrumentation, photographic optical systems and cinematography. Mechanical aptitude desired but not required for these engineering positions. Send resume to Ellis P. Faro, c/o Scientific Employment, Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.

Spotlight on

Gevapan 30, Type 165 is favored by experienced cameramen all over the world. This film gives uniform results, even when the shooting schedule calls for both interior and exterior shots. The fine grain and excellent gradation give extremely good definition with excellent tone rendition. The special sensitivity of this film also minimizes make-up and other photographic problems.

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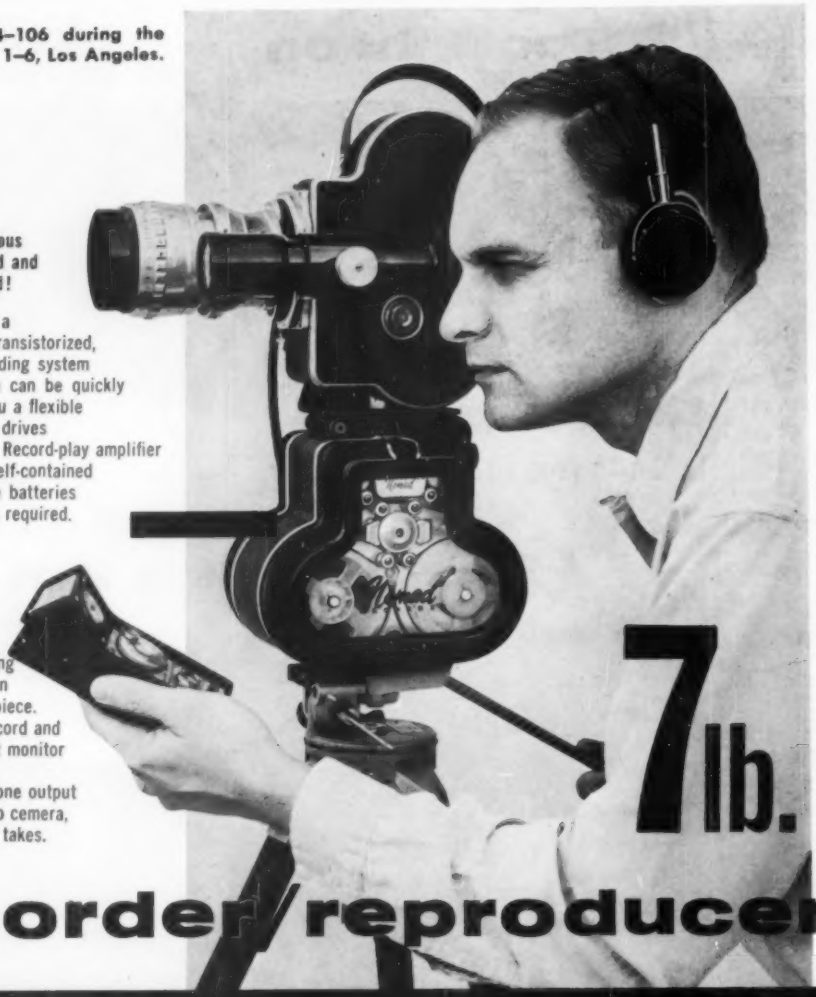

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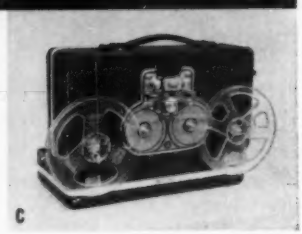

C

A. Nomad film is split 16mm. Channel #1 on the twin-track record head is used for lip-sync and narrative recording on location. Later, complimentary music from phonograph or tape recorder is "dubbed" on channel #2. Simultaneous playback thru the full width play head mixes music and voice, producing theatre-quality sound.
B. For lengthy sequences, a regular camera D.C. motor can be attached to the Nomad, driving both recorder and camera thru the flexible cable. There is a 180 rpm output in the Nomad camera interlock and a 1440 rpm output for projector interlock. Playback can be double-system, or a 1:1 interlocked transfer from recorder to a striped release print can be made with a magnetic sound projector.
C. Basic film capacity is 100 ft.; the use of simple adapters can increase capacity to 400 ft. or 1200 ft. Entire Nomad system fits compactly into small carrying case.

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Meeting Calendar

American Chemical Society, National Meeting, Apr. 5–14, 1960, Cleveland, Ohio.
Optical Society of America, Spring Meeting, Apr. 7–9, 1960, Hotel Statler, Washington, D.C.
Inter-Society Color Council, 29th Annual Meeting, Apr. 11, 12, 1960, Philadelphia Museum College of Art, Philadelphia.
Microwave Research Institute of Brooklyn Polytechnic Institute, Tenth International Symposium on Active Networks and Feedback Systems, Apr. 19–21, Engineering Societies Bldg., 33 West 39th St., New York
IRE, South West Regional Conference and Electronics Show, Apr. 20–22, 1960, Shamrock-Hilton Hotel, Houston, Texas.
Manned Space Stations Symposium, Apr. 20–22, 1960, Ambassador Hotel, Los Angeles.
87th Semiannual Convention of the SMPTE, including Equipment Exhibit, May 1–7, 1960, Ambassador Hotel, Los Angeles.
IRE National Aeronautical Electronics Conference, May 2–4, 1960, Dayton, Ohio.
American Rocket Society, May 9–12, 1960, Ambassador Hotel, Los Angeles.
Society of Photographic Scientists and Engineers Annual Conference and Equipment Exhibit, May 9–13, 1960, Hotel Miramar, Santa Monica, Calif.
Society of Military Engineers, National Convention, May 16, 17, 1960, Washington, D.C.
ASME, Design Engineering Div. Conference, May 23, 1960, New York.
Design Engineering Show, May 23–26, 1960, Coliseum, New York.
Institute of the Aeronautical Sciences, National Summer Meeting, Mid-June, 1960, Los Angeles.
Acoustical Society of America, Spring Meeting, June 9–11, 1960, Providence, R.I.
National Society of Professional Engineers, Annual Meeting, June 9–11, 1960, Statler Hotel, Boston, Mass.
International Electronic, Nuclear and Cinematographic Exhibition, June 15–July 5, 1960, Rome, Italy.
AIEE, Summer General Meeting, June 19–24, 1960, Atlantic City, N.J.
American Society for Engineering Education, Annual Meeting, June 20–24, 1960, Purdue Univ., West Lafayette, Ind.
First Congress International Federation of Automatic Control, June 25–July 9, 1960, Moscow, U.S.S.R.
American Society for Testing Materials, Annual Meeting and Apparatus Exhibit, June 26–July 1, 1960, Chalfonte-Haddon Hall, Atlantic City, N.J.
AIEE, Pacific General Meeting, Aug. 8–12, 1960, San Diego, Calif.
European Conference on Electron Microscopy, Aug. 29–Sept. 3, 1960., Delft, Netherlands.
AIEE Fall General Meeting, Oct. 9–14, Chicago.
NEC National Electronics Conference, Oct. 10–12, 1960, Hotel Sherman, Chicago.
Fifth International High-Speed Congress and Equipment Exhibit, sponsored by the SMPTE, Oct. 16–22, 1960, Sheraton-Park Hotel, Washington, D.C.
Symposium on Space Navigation, Oct. 19–21, 1960, Columbus, Ohio.
89th Semiannual Convention of the SMPTE, May 7–12, 1961, King Edward Sheraton, Toronto.
90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N.Y.
91st Semiannual Convention of the SMPTE, Apr. 30-May 4, 1962, Ambassador Hotel, Los Angeles.
92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members will be published in the April 1960 Journal.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

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Comprehensive Service Corporation
Consolidated Film Industries
Dage Television Division of Thompson Ramo Wooldridge Inc.
DeFrenes Company
DeLuxe Laboratories, Inc.
Desilu Productions, Inc.
Du Art Film Laboratories, Inc.
  Tri Art Color Corporation
Dupont of Canada, Ltd.
E. I. du Pont de Nemours & Co., Inc.
Eastern Effects, Inc.
Eastman Kodak Company
Electronic Systems, Inc.
Elgeet Optical Company, Inc.
Max Factor & Co.
Filmline Corporation
General Electric Company
General Film Laboratories Corporation
General Precision Laboratory Incorporated
W. J. German, Inc.
Gevaert Photo-Producten N. V.
Guffanti Film Laboratories, Inc.
Frank Hermfeld Engineering Corp.
Hi-Speed Equipment Incorporated
Hollywood Film Company
Hollywood Film Enterprises, Inc.
Houston Fearless Company
Philip A. Hunt Company
Hunt's Theatres
Hurley Screen Company
JM Developments, Inc.
The Jam Handy Organization, Inc.
Jamieson Film Co.
The Kalart Company, Inc.
  Victor Animatograph Corporation
Kear & Kennedy Engineering
Kollmorgen Optical Corporation
Labcraft International Corporation
Laboratoires Cinématographiques CTM S. A.
Lipsner-Smith Corporation
Lorraine Orlux Carbons
Magno Sound, Inc.
Mecca Film Laboratories Corporation
Minnesota Mining & Manufacturing Co.
Mitchell Camera Corporation
Mole-Richardson Co.
Motion Picture Association of America, Inc.
  Allied Artists Pictures Corporation
  Buena Vista Film Distribution Company, Inc.
  Columbia Pictures Corporation
  Loew's Incorporated
  Paramount Pictures Corporation
  Twentieth Century-Fox Film Corp.
  United Artists Corporation
  Universal Pictures Company, Inc.
  Warner Bros. Pictures, Inc.
Motion Picture Enterprises, Inc.
Motion Picture Laboratories, Inc.
Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
Moviola Manufacturing Co.
National Carbon Company, A Division of Union Carbide and Carbon Corporation
National Screen Service Corporation
National Theatre Supply Company
Neumade Products Corporation
Northwest Sound Service, Inc.
Panavision Incorporated
Pathé Laboratories, Inc.
Pittsburgh Motion Picture Laboratory
Warren Conrad Portman Company
Precision Laboratories (Division of Precision Cine Equipment Corporation)
Prestoseal Mfg. Corp.
Producers Service Co.
Radio Corporation of America
  National Broadcasting Company
  Broadcast and Television Equipment Division.
Rank Precision Industries Ltd.
Rapid Film Technique, Inc.
Reid H. Ray Film Industries, Inc.
Reeves Sound Studios, Inc.
Richardson Camera Company, Inc.
RIVA-Munich
Charles Ross, Inc.
L. B. Russell Chemicals, Inc.
Ryder Sound Services, Inc.
Scripts By Oeveste Granducci, Inc.
Southwest Film Laboratory, Inc.
The Strong Electric Company
Sylvania Electric Products, Inc.
Technicolor Corporation
TELIC, Incorporated
Time Automated Manufacturing Company, Inc.
Titra Film Laboratories, Inc.
Trans-Canada Films Ltd.
Van Praag Productions
Alexander F. Victor Enterprises, Inc.
Westinghouse Electric Corporation
Westrex Corporation
Wilding Inc.
Wollensak Optical Company

The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee, Byron Roudabush, c/o Byron Motion Pictures, Inc., 1226 Wisconsin Ave., N.W., Washington 7, D.C.